A Comparative Analysis of the Park-and-Ride/Transit-Oriented Development Tradeoff

by

Jason Burgess

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Author

Department of Urban Studies and Planning

Professor P. Christopher Zegras
Thesis Supervisor

Professor Langley Keyes
Chair, MCP Committee

Accepted by

Department of Urban Studies and Planning
Abstract

Park-and-ride provided metro regions with a mechanism to reduce commute-generated vehicle-miles traveled, by capturing vehicles in or near their home communities and allowing their drivers to travel to their destinations via transit. The hypothesis underlying this study is that the loss of commuter parking to transit-oriented development involves a tradeoff of one set of benefits (and costs) for another. By assessing the performance of existing park-and-ride facilities, and comparing the associated costs and benefits with those we might expect from transit-oriented development, decision-makers might make land-use decisions that more effectively advance local and regional goals. To that end, this study sets up a methodology to allow for an “apples-to-apples” comparison of the impacts of park-and-ride and transit-oriented development on regional vehicle-miles traveled. This methodology is flexible in its methods and its application, so that it may be adapted to a range of modeling tools and techniques, available data, and regional contexts. Data collected from commuter rail stations in the Boston metro region suggests that park-and-ride performance is more a factor of station distance from commuters’ destinations than of the position of a station relative to others on the transit line. This result indicates that redevelopment of park-and-ride facilities in the Boston metro region should focus on cost-inefficient facilities in communities nearer to the CBD, where the benefits of transit-oriented development are also often greater.
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Jess Burgess

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Introduction

For decades, park-and-ride facilities have been a common sight at rail transit stations in U.S. metropolitan regions (Frost 1974, Noel 1988, Turnbull 2004). Park-and-ride provided metro regions with a mechanism to reduce commute-generated vehicle-miles traveled, by capturing vehicles in or near their home communities and allowing their drivers to travel to their destinations via transit. Park-and-ride is an expensive service for transit agencies to offer, however, and recently a number of metro areas have begun to redevelop former park-and-ride lots to reduce their costs, as well as to provide transit-accessible housing, shopping and office space, a development type commonly referred-to as transit-oriented development (TOD) (Bernick 1997, Cervero 1994, 2001, 2004). The sale of large parcels of land adjacent to rail transit stations has provided transit agencies in these areas with significant windfalls, and has resulted in the conversion of large, often-empty parking lots to vibrant, mixed-use communities, the benefits of which are attractive and clearly visible.

The hypothesis underlying this study is that the loss of commuter parking to transit-oriented development involves a tradeoff of one set of benefits (and costs) for another. This tradeoff is context dependent: the exchange of benefits when a blighted, underused parking lot is converted to a healthy community, may be very different than when a well-functioning lot is redeveloped to make way for a neighborhood where no one wants to live. This study attempts to answer the question, What factors govern this tradeoff? If we are able to assess the performance of existing park-and-ride facilities, and compare the associated costs and benefits with those we might expect from TOD, this might allow us to make land-use decisions that more effectively advance local and regional goals.

This study sets up a methodology to allow for an "apples-to-apples" comparison of the impacts of park-and-ride and TOD on regional vehicle-miles traveled (VMT). This methodology is flexible in its methods and its application, so that it may be adapted to a range of modeling tools and techniques, available data, and regional contexts. This is important because of the context-dependent character of the park-and-ride/TOD benefits tradeoff, which may appear different in the New York metro region than it does at the state level in California, or at the level of the U.S. as a nation. The aim of the methodology is to be flexible enough to be adaptable to such varying conditions and modes of analysis.

The tradeoff methodology is then applied to the Boston metro region, using a rigorous case study approach at eight commuter rail stations. This demonstrates an application of the methodology, and provides a set of results with applicability to land-use planning and policy for the regional commuter rail system. The results from the Boston commuter rail case study analysis suggest several implications for transit-land use policies in this region.

The Boston case study results indicate that, in every case, park-and-ride provides a
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much greater reduction in commute VMT than TOD, for a given amount of land area. However the cost of providing station parking is very high, an important consideration for a cost-sensitive transit agency. In general, the results show that park-and-ride facilities perform more cost-effectively in areas further from the CBD, and less effectively in inner-ring communities, where the greater number of transportation options lowers facility performance. This conclusion clarifies somewhat a claim in the park-and-ride literature, that park-and-ride facilities often function best at terminal stations (Turnbull et al., 2004; Kim, 1997). Rather, it appears that, for commuter rail stations in the Boston metro region, park-and-ride performance is more a factor of station distance from commuters’ destinations than of the position of a station relative to others on the transit line. This result suggests that redevelopment of park-and-ride facilities should focus on cost-inefficient facilities in communities nearer to the CBD, where demand for housing and commercial development is also likely to be higher.

Chapter 1 provides an overview to the transit-land use literature. Chapter 2 introduces the tradeoff-comparison methodology, outlining its essential structure and suggesting some of the ways in which it might be applied. Chapter 3 briefly lays out the the history and current transit system characteristics for the Boston case study. Chapter 4 demonstrates the application of the tradeoff-comparison methodology to the Boston case, and the techniques employed, as well as the limitations of this approach. Chapter 5 presents the results of the analysis for the eight Boston region case study stations. Following from these results, Chapter 6 suggests some implications for land-use policy at commuter rail stations in the Boston region, and sets the ground for application of the methodology to cases beyond this region.
Chapter 1
Overview of the Transit-Land Use Literature

Park-and-ride describes an operation that enables travelers to transfer from less-efficient private automobiles to more efficient modes of transportation, typically carpool or mass transit. Drivers park their automobiles at a designated facility and travel via the relatively more efficient mode from that facility to their destination. In the U.S., most large park-and-ride facilities (with capacity >100 spaces) mostly adjoin rail transit stations, and most are owned by transit agencies (Turnbull et al., 2004) — though many urban areas maintain smaller facilities at bus stations or at highway interchanges for carpoolers. The majority of park-and-ride capacity in the U.S. currently exists at rail transit stations, particularly in suburban communities or rural areas (Turnbull et al., 2004; Noel, 1988; Cervero, 1994).

Park-and-ride is considered by some observers to be the best way to extend public transit service, and rail transit in particular, to low-density suburban communities where it would not otherwise be financially feasible to provide service (Pushkarev and Zupan, 1977). Whereas in dense urban areas a majority of transit riders walk to access rail stations or bus stops, in suburban and rural areas, increased distances and decreased safety and comfort for pedestrians put transit services out of reach of most residents. Transit station parking facilities allow commuters to drive to transit stations, leave their cars and continue their commute on transit, effectively extending transit access to populations far beyond the small area within walking distance of a station. This extension of access attracts greater ridership to stations than could occur otherwise, increasing transit agency fare revenues.

Park-and-ride generates benefits for a wide range of groups. Benefits to users may include cost savings, time savings and increased comfort. Benefits to non-users may include reductions in road congestion and airborne pollutants, better land use in urban centers, and economic development region-wide. Park-and-ride already provides these benefits in many U.S. cities, helping them to deal with issues of congestion and air pollution.

However, some researchers question the effectiveness of park-and-ride, citing the costs to operate and develop facilities, and in forgone transit-accessible development opportunities on the land now occupied by parking lots (Parkhurst, 1995; Bernick and Cervero, 1997). Park-and-ride is criticized also for building-in auto dependence, when its goal is to reduce vehicle travel. An alternative land-use, transit-oriented development
Chapter 1. Overview of the Transit-Land Use Literature

which better capitalizes on the unique value of transit access and seeks to reduce auto dependence — appears in many ways to offer a better future for urban areas. What, then, is the future of park-and-ride, and of transit station land-use? Do transit-oriented development and urban villages offer a better future for metro-regions?

This paper begins from an assumption that neither park-and-ride nor transit-oriented development (nor any other one land-use, for that matter) offer a ‘one-size-fits all’ best option for station-area land. Rather, the attributes, costs and benefits of each of these uses are better suited to different types places, such that, within the same region, park-and-ride will produce the best results at the lowest cost in one place, while TOD is more effective at another. Metro-regions, then, need to better understand just which characteristics of a place determine the value of each land-use — station parking or TOD — and a policy to induce development of those best uses in their right places. This paper contributes a better understanding of the costs and benefits associated with these competing land-uses, and of some of the characteristics of place that may determine their relative attractiveness. It begins with a brief review of the literature regarding both park-and-ride and transit-oriented development, and a concise history of their development. Then it presents the results of a basic two-part process- and impact-model for eight commuter rail stations in the Boston region, and ends with a discussion of their implications for land-use planning and policy at transit stations.

A second assumption embedded in this paper is the notion that the “best” station-area land-use will be determined as much by the particular goals and plans of a region or a community, as by the effectiveness with which that use can be expected to deliver benefits. This is because park-and-ride and TOD have very different forms and consequences. An urban area with strong growth pressures, a need for new housing, and relatively less congestion and/or air-quality problems might rightly make the choice to develop strictly TOD, as the benefits it provides are themselves more attractive in that region than park-and-ride’s benefits. The “best-ness” of one use or another is determined as much by the goals and desires held in a community or region as by its objective efficiency in delivering benefits.

This chapter outlines the discussion of the particular costs and benefits that accompany park-and-ride development, and its wider impacts on cities and regions. It includes a brief history of park-and-ride in the U.S. and in the Boston area, and a look at its functions in the current U.S. urban context, with particular attention to the Boston region. Following is a review of the critical literature and a discussion of the future possibilities for park-and-ride and transit-area land use, and their implications for cities, energy consumption and climate change.

1.1 Park-and-Ride: Benefits, Costs and Problems

1.1.1 Benefits of Park-and-Ride

One aspect of park-and-ride development that makes it particularly attractive for cities and public agencies is that it offers a politically palatable solution to common urban problems of traffic congestion and poor air-quality without placing prohibitive restrictions on any
1.1. Park-and-Ride: Benefits, Costs and Problems

activity or group (Meek, 2008). Unlike many transportation demand management (TDM) policy programs, which tend to privilege an activity or group to the disadvantage of another, park-and-ride provides benefits to a wide range of urban constituents, exposing only a limited public to its costs. Unlike conservation measures, which ask people to do without, park-and-ride development seems to solve problems simply by providing a new set of public benefits that the public has the option to enjoy. These benefits are not without costs, but these costs are often obscure or locally-constrained, as will be discussed in §1.1.3.

Benefits to Users

Park-and-Ride service may offer a number of benefits to users, in particular the extension of access to rapid transit service beyond areas from which it is possible to access that service by walk, bike or bus. The effectiveness and importance of this function for suburban residents is visible in surveys of transit riders in cities across the U.S. One study of 34 stations on San Francisco’s BART transit system, found that the 90% ridership catchment area for suburban center stations (virtually all of which offered park-and-ride) was on average about 15 times greater than that of downtown stations (Cervero, 2001). This increased catchment area allows suburban center stations to serve a population of similar size to downtown stations, despite a great disparity in population and employment densities between these area types. A similar study, from the Seattle area, found that 85% catchment areas for suburban stations frequently extended for 12 miles or more, along freeways and major arterial roads (Turnbull et al., 2004).

Park-and-ride is critical to transit systems’ ridership outside of the urban core. A large share of transit riders boarding at suburban-area stations access those stations via park-and-ride: 39% of Bay Area Rapid Transit (BART) rail transit riders reported using a BART park-and-ride facility to access the system (Turnbull et al., 2004), 55% of ridership on Chicago’s Metra regional rail service used park-and-ride (Ferguson, 2000, in Turnbull, 2004), and on the Lindenwood High Speed Line between Philadelphia and the New Jersey suburbs, 57% of riders were found to have utilized a park-and-ride facility (Ellis, Burnett and Rassam, 1971, in Turnbull, 2004). These data reflect the importance of park-and-ride to suburban rapid transit, both for riders and service providers.

Because it widely extends access to transit, park-and-ride service extends many of the benefits that accompany transit access, including: reduced cost of commuting (in fuel, parking, vehicle wear and maintenance costs), faster commute times and increased comfort vs. driving, amenities at facilities/stations, and others. Demand for park-and-ride service is greater at facilities offering more and better benefits to users (TCRP rpt. 95 ch. 3). As one might expect, certain benefit types are more important to park-and-ride users than others. The results of user preference surveys conducted by several major transit agencies and others reveal that the greatest incentives for park-and-ride use were reduced cost, reduced stress from driving, and faster travel time, though these factors vary in importance among survey sites (Turnbull et al., 2004). A survey of park-and-ride users on the BART system in San Francisco/Oakland, CA, revealed that saving money (53%) was the most cited reason for using park-and-ride, followed by environmental considerations (39%), and avoiding the stress caused by driving to their destination (32%). Saving time compared to driving was cited by only 17% of BART users (results add up to more than 100% as respondents
were asked to select as many factors as they liked) (Lave, Billheimer and McNally, 1997). The most commonly-cited factor among park-and-ride users on the CTA system in Greater Chicago, meanwhile, was a faster commute time compared to driving (35%), followed by dislike for driving (24%), and avoidance of parking costs at their destination (21%) (Urbitran Associates and SG Associates, 1999). While the order of importance among factors for using park-and-ride service varies according to local conditions, the most important of those factors remain generally constant. Reduced cost, faster travel time and less stress/greater comfort compared to driving are the most important factors motivating park-and-ride use in the U.S.

![Figure 1.1: Park-and-ride lot serving a light rail station](image)

**Benefits to the Region**

Park-and-ride development has been driven in large part by the belief that it offers benefits not only for its users, but for municipalities, transit agencies and entire urban populations. Supporters claim that park-and-ride can help to reduce roadway congestion, both on highways and city streets, improve urban air-quality, attractiveness and livability, and generate new economic development opportunities for city center and suburban communities alike. These system-wide benefits stem from several essential functions of park-and-ride: displacement of vehicles and parking capacity from the city center to the suburban fringe; a reduction in VMT attributable to shorter commute trips; and expansion of transit accessibility, particularly in low-density suburban areas.

The displacement of parking capacity from the city center to outlying communities produces a number of benefits for municipalities and urban residents. By providing parking capacity in lower-density areas outside of the city center, park-and-ride reduces the need for parking in dense urban areas, where the value of land is greater. Parcels that were formerly needed for parking are freed up for development, creating job and economic growth, new amenities for residents and a more attractive and vibrant city center.

Fewer parking spaces in urban areas, and additional parking capacity at suburban transit stations, means that many commuters must leave their vehicles in their home communities.
To most observers, this is the most important effect of park-and-ride for cities. By keeping thousands (or tens of thousands, as in Boston and many other large cities) of vehicles in their home communities everyday, park-and-ride reduces peak hour demand for highway capacity and congestion throughout the metropolitan area.

Another effect of shorter commute trips by auto modes is an air-quality benefit due to the reduction in VMT and vehicle emissions. Because it can significantly reduce driving distances, park-and-ride may reduce emissions of carbon dioxide (CO₂) and air pollutants including hydrocarbons (HC), nitrogen oxide (NOx) and carbon monoxide (CO). But, due to the cold-start effect, whereby automobiles emit more pollutants during the first several miles of driving, overall reductions in airborne pollutants will be less than the reduction in vehicle miles. This is because, though park-and-ride reduces trip distances, it does not reduce the number of trips. HCs, CO and NOx remain lower in the atmosphere and relatively near to their point of emission. This means that airborne pollutants, like parking capacity, can be displaced, somewhat, by transit station parking. Fewer vehicles in city center areas leads to a reduction in local air pollutants downtown, by capturing vehicles in their home communities, outside the center. However, another consequence is that vehicle concentrations at transit station parking facilities can have significant negative impacts on local air quality in these areas. Cold starts aren't as much of a problem for CO₂ emissions; VMT reductions from park-and-ride result directly in lower CO₂ emissions. This is encouraging, and suggests that park-and-ride expansion may be an effective way to significantly reduce transportation sector carbon emissions, a critical task in addressing global climate change.

It should be noted that park-and-ride alone is not a solution at the scale of the challenge. There are more than 60 million vehicle-miles traveled in the Boston region everyday, and growing (C.T.P.S., 2005). Park-and-ride expansion will never achieve the scale of reductions that are necessary. Park-and-ride expansion in the Boston region between 1990 and 2000 was outpaced by growth in VMT 12-to-1.

Park-and-ride facilities are critical elements in transit service expansion in U.S. cities. Facilities themselves often operate at a financial loss to transit agencies — because of low (or no) cost to park, lots attract less in revenue than they require to build and operate — but they serve as critical ridership attractors in suburban areas. In areas where residential and employment densities are low, and few would-be riders are able or willing to walk to access transit services, park-and-ride facilities extend access to transit to thousands more potential riders. Pushkarev and Zupan analyzed the fiscal viability of different types of transit services in areas of varying density, and determined that rapid rail transit required a minimum residential density of 12 dwelling units per acre (light rail service requires 9 d.u./acre) in order to attract sufficient ridership to support the service. Commuter rail, however, which in their analysis operates fewer trains than light- and and heavy-rail transit (which most often operate with continual frequent service throughout the day), and may be served by park-and-ride facilities, is viable at densities as low as 1–2 d.u./acre. Assuming between 10 and 20 park-and-ride trips are generated per square mile per day, on commuter rail service, a ridership catchment area of 7–12 square miles is sufficient to provide the number of riders needed to achieve service viability (Pushkarev and Zupan, 1977).

A recent study of rapid light rail expansion across many North American cities showed that park-and-ride facilities are an integral part of transit system expansions (Kim, 1997;
Chapter 1. Overview of the Transit-Land Use Literature

Baum-Snow and Kahn, 2000). This integral role is easy to understand: the dense urban centers in America for the most part already operate rapid transit systems, so expansions will occur largely in lower-density areas, outside of these centers (commuter rail expansion in the Boston, New York City and Philadelphia regions), or as new rail systems in younger, faster-growing metro areas (such as Houston, Phoenix and Portland) that are relatively low-density throughout the urban area. This outward growth of transit service expansion mirrors the population movement outward from urban centers, to the suburbs and outlying areas. Park-and-ride provides a ready-made solution to the problem of greater home-to-station distances in low-density areas, particularly as vehicle ownership levels tend to be higher than average in these suburban communities (Kim, 1997). As federal legislation and public sentiment begin to push cities to provide quality alternatives to auto travel, despite the mostly low-density, auto-dominated American land-use context, park-and-ride has emerged as one of the most viable strategies to expand transit services and use (Noel, 1988; Turnbull et al., 2004).

1.1.2 Questioning the Benefits of Park-and-Ride

Recently, several observers have begun to question whether park-and-ride is really able to deliver its promised benefits (Parkhurst, 1995; Meek, 2008). They point out two degrading factors, processes that reduce the amount of actual achievable benefit that station parking can provide. The most-cited processes are trip replacement and cold starts.

Graham Parkhurst, researching park-and-ride facilities in several English cities, suggests that park-and-ride can actually lead to an overall increase in regional VMT, and accompanying increases in traffic congestion and pollutant emissions (Parkhurst, 1995, 2000). The problem, according to Parkhurst, is that when park-and-ride users are removed from highways and downtown streets — their vehicles captured at transit station parking facilities — the new roadway capacity that is opened up in this way is immediately filled in again by other users. It is at its core the classic induced demand problem: increased roadway capacity leads to better traffic flow and faster trips, increasing the utility of roadway travel for all potential users. This increased utility will attract new trips — Parkhurst suggests that these new roadway trips will be split among commuters switching from other modes (transit, carpool), new trips with beginning- and end-points within the region (intra-region), and new trips simply passing through the region (inter-region) (Parkhurst, 1995). In the absence of any intervention to restrict them, new roadway trips will replace some portion of the trips originally displaced through the implementation of park-and-ride. In the grimmest analyses, trip growth and mode-switching will continue until the utility of roadway travel returns to its previous equilibrium. The result of this would be a net increase in regional travel (and emissions), but no increase in roadway congestion.

Though to this point little research has been done on this subject, one complicating factor in attempts to mitigate induced demand prompted by park-and-ride is that attempts so far have effects that bias against intra-region trips, while largely failing to account for inter-region trips. The most common transportation demand management technique to accompany park-and-ride development, both in the U.S. and Britain has been the reduction or limitation of parking capacity in city centers (Parkhurst, 1995; Meek, 2008; Turnbull
et al., 2004). Parking reductions limit the ability of travelers to drive and park at their destination, and have been shown to be an effective way to induce balanced mode split (Cervero, 2001), by increasing the cost (in money and/or time) of driving — a study of Bay Area travel patterns found that access to free parking at their destination was the single most important factor in determining whether area residents would drive or take transit (Cervero, 2004).

The air quality impacts of new trip generation are significantly greater than is evident simply from the growth in VMT. Because of combustion-engine inefficiencies, most automobiles emit air pollutants at a far greater rate during the first several miles of driving than during later miles, once the engine is warmed up. Numerous studies quote the data from an emissions field test of a number of automobiles that found that over the course of a 3 miles trip (similar to the average park-and-ride commute distance to many facilities, though the median trip tends to be somewhat shorter) the automobiles emitted 84% of the HCs and 54% of the NOx as was emitted during a 10 mile trip (Bernick and Cervero, 1997; Cervero, 1994).

1.1.3 Park-and-Ride Costs: Development and Operation

The costs of park-and-ride fall loosely into three categories: development and operation, opportunity cost, and non-financial burdens. Development costs include the cost to acquire the land and build the parking facility. Surface parking lots are much cheaper to build than structured parking, but surface parking requires greater land area, and therefore entails a greater opportunity cost for that land. Construction costs remain generally constant throughout a region, but the value of land clearly does not. For this reason, the type of parking (in structured towers or surface lots) often varies according to the value of the land on which it is built.

Construction costs for parking facilities represent a major expense to would-be developers: the Massachusetts Bay Transportation Authority projects per-space costs at roughly $3,000 for surface parking, $25,000 for structured parking (Ron Morgan, 2008, personal communication). The choice to develop a large parcel of land as park-and-ride often represents a significant opportunity cost to transit agencies. Park-and-ride service does often attract greater transit ridership in low-density areas, but often operates at a net loss for the transit agency (Turnbull et al., 2004). Because the land used for a parking facility necessarily has excellent access to transit service, land used for park-and-ride is in many cases attractive to development interests, and could be rented or sold to generate a considerable windfall for the transit agency. Rent data from the Boston region indicates that, for each of the 9 facilities discussed in chapters 4 and 5, the opportunity cost of the land on which the parking is placed is by far the greatest economic cost of providing park-and-ride (Research, 2007a,b).

Land conversion represents another significant cost of developing new park-and-ride facilities. Large surface parking lots are difficult to site in even modestly-dense areas, and so are often developed on the suburban fringe, or in rural areas. Siting facilities on greenfield land can have impacts on open space availability and species habitat.

Development costs are only one part of the local impacts of park-and-ride service; the impacts from facility operation may also be considerable, and can affect whole
communities. Large facilities, with capacity in the thousands of automobiles, can generate traffic congestion on highway on/off ramps and the local street network, causing inconvenience and negative impacts for economic development. All that traffic naturally leads to increased pollutant emissions, particularly when hot-soak effects (continued emissions of HCs for a period of time after a vehicle is turned off) are considered, and may lead to declines in local air-quality. Park-and-ride facilities may also have negative effects on the pedestrian environment, though this impact could be mitigated with better facility design, as is occurring in some areas. Recognizing these burdens, many communities have resisted park-and-ride development. Resistance to facility siting can impose additional political costs to park-and-ride development.

1.2 Park-and-Ride: History & Current Context

1.2.1 Humble Beginnings: 1930s–1980

Park-and-ride emerged organically on the fringes of a number of U.S. cities during the 1930s, as motorists parked their vehicles in fields and empty lots near bus and rail lines, the speed and cost of which, in those times, provided large user benefits compared to commuting by automobile (Noel, 1988). The City of Detroit operated eight small parking lots at gasoline service stations located along bus routes (Bullard and Christiansen, 1983). The first large-scale park-and-ride facility was built by the Long Island Railroad Co. in 1939, on the site of that year’s World’s Fair (Frost, 1974). Transit companies were largely responsible for the growth of interest in the phenomenon over the next several decades, and by the late 1960s 36 U.S. cities had “ongoing major involvement in some form of park-and-ride activity” (Noel, 1988).

The Federal Highway Act of 1968 inaugurated the involvement of the federal government in the development of park-and-ride facilities. The Act authorized federal involvement and 50% federal funding for a series of demonstration projects located along the federal highway system. The first facility built with federal assistance was a 12-acre site in Woodbridge, NJ, in 1968, and served by the Penn Central Railroad (Ellis, 1971). The Clean Air Act of 1970, and the OPEC embargo in 1973 prompted renewed interest in public mass transit, and with the Emergency Highway Energy Act of 1974 the Federal Highway Administration (FHWA) expanded its role in support of intermodalism and park-and-ride (Noel, 1988). The 1977 and 1978 Amendments to the Federal Clean Air Act, and a coordinated effort by FHWA, the Urban Mass Transit Administration (UMTA) and the Environmental Protection Agency (EPA) set energy conservation, improved air-quality and efficient use of transit as goals for the national transportation sector. Likewise, they mandated that cities seek to meet these goals through Transportation Improvement Programs (TIP), which were now required in order to receive federal funding for transportation projects. Park-and-ride was established as one of several strategies to manage their transportation systems, a requirement under the TIP provision (Noel, 1988). These legislative actions set the policy stage for the past 25 years of park-and-ride development.
1.2.2 The Boom Years: 1980-2000

Transit agencies greatly expanded parking capacity at transit stations in many large urban areas between the mid-1980s and the late-1990s. In 1988, cities and transit agencies within California operated 270 intermodal parking facilities, with total capacity of 15,185 parking spaces (Noel, 1988). In 2003, three largest transit agencies in the state — Bay Area Rapid Transit (BART), Metrolink L.A., and Caltrain — together operated 114 facilities, with a total capacity of more than 65,625 parking spaces (B.A.R.T., 2003). Over the course of fifteen years, these three agencies built more than four times the park-and-ride as had previously existed across California (and this figure is generous, as the 1988 figure includes some municipal lots for carpoolers, not located at transit stations).

These parking capacity expansions have in general not outpaced demand for parking at transit stations. Caltrain facilities reported 78% utilization in 1998, and Metrolink L.A. reported 75% utilization in 1999 (Turnbull et al., 2004). Though system-wide utilization data is not available for the BART system, agency reports indicate that demand for parking at BART stations is high, and has forced the agency to plan significant expansions of existing station parking facilities, as well as to plan larger facilities at future stations (B.A.R.T., 2003).

Despite the large-scale capacity expansions undertaken by many large transportation agencies, the lack of sufficient parking at transit stations in suburban communities is a growing concern around Boston and in other metro regions (Long, 2008). In response to increasing demand for station parking, many transit agencies planned larger facilities at new stations (often in low-density areas), but this only solves part of the problem. Commuters are averse to driving any significant distance away from their destination, in order to park and take transit back the other direction (Wang et al., 2004). Demand for parking at inner-ring suburban transit stations cannot be accommodated by facility development at stations further from the CBD, where much expansion and new development currently occurs. The problem of whether to accommodate rising demand for parking, or to develop parking land as TOD for revenue generation and other purposes, is a critical question for transit agencies and municipalities.

1.2.3 Management & Operation of Park-and-Ride

All of the park-and-ride lots operated by the MBTA, as is the case in most places, are operated on a first-come-first-served basis. Once a facility has filled to capacity — sometimes an hour or more before the last a.m. train departs (C.T.P.S., 2006) — would-be users are forced to find parking elsewhere, or complete their commute by car. In some urban areas, including the Bay Area and Metropolitan New York, programs allowing monthly or daily reservation of park-and-ride spaces are underway; some observers hope that increased certainty of available capacity will induce greater demand for park-and-ride in these areas (Shaheen and Kemmerer, 2007). Slightly more than half of MBTA park-and-ride lots at commuter rail stations; at most facilities this cost is $2/day. A handful of stations in inner-ring communities charge as much as $3/day, but facilities with no cost to park are more common (M.B.T.A., 2006). At the MBTA, which contracts out operations of park-and-ride facilities on its land, revenue from park-and-ride lots covers the cost of
maintenance, but does not generate net revenue for the agency (Ron Morgan, personal communication).

1.3 Transit-Oriented Development: A Better Use of Transit Station Land?

Even as park-and-ride has expanded in the last 15 years, many observers of land-use and transportation issues, community development advocates, urban designers and developers have begun to advocate for a shift in the general approach to development of land nearest to transit stations. Transit-oriented development, in general, implies a mixed-use, moderate- to high-density development pattern, emphasizing pedestrian connections between the transit station and the homes and workplaces that make up the community (Cervero, 1994, 2004; Bernick and Cervero, 1997). TOD seeks to enhance walkability (within the community) and transit use (for trips outside of it) through a focus on “the three Ds”: density, diversity and design (Cervero, 2001; Newman, 1999). Dense, diverse, well-designed communities are walkable communities, TOD proponents argue, because density and a diversity of uses allow for many of the things that people want and need to be located close together, and well-designed buildings, sidewalks, streets and public areas will be safe, interesting and enjoyable places for residents, local employees and others.

Though the form of each community or new development is unique, a number of ideals and themes are shared across virtually all TODs. Transit stations are frequently given a central position in the community, both physically and figuratively. Because two critical organizing principles of TOD are that it provide a high degree of access to transit for all residents/users, and a high-quality pedestrian environment, all points within the community should be a short walk (no more than 10 minutes or so) from the station. The organization of land-uses often follows a common scheme: civic buildings or major public amenities nearest the center, followed outward by high-density office buildings and residential apartment towers, then moderate density residential and commercial uses — often as mixed uses within the same buildings, and moderate- to low-density residential (row houses, duplexes) and industrial uses at the fringes of the community (Bernick and Cervero, 1997; Cervero, 2001, 2004).

Because of their focus toward walkability and pedestrian access throughout the community, transit-oriented developments are necessarily fairly small in terms of land area. A number of researchers, as well as planning and engineering firms designing TODs, prescribe to the rule that Americans are generally not willing to walk more than 1/2 mile, and that developments should therefore not extend beyond a 1/2 mile radius of the transit station. Cervero (2001) and others have demonstrated that Americans’ willingness to walk is more complex, and depends on factors including pedestrian safety and comfort, as well as the amount of interest generated by points along the route — a popular main street or plaza is thought to generate high interest for the pedestrian, blank walls and empty sidewalks to generate little. Cervero shows that many people are willing to walk distances of a mile or more, if they are safe, comfortable and interested in what surrounds them. But even at this outer limit of willingness to walk, the total area of any single transit-oriented community
1.3. Transit-Oriented Development: A Better Use of Transit Station Land?

must remain fairly small.

1.3.1 Travel Impacts of TOD

According to advocates for TOD, this tight-knit, transit-centered form of development produces a number of benefits, including positive travel effects, community revitalization and development, environmental sustainability, increased real estate values, and, according to some, benefits in increased sociability and public health. Of particular interest for this study are TOD's impacts on travel behavior, particularly on mode split impacts for several trip types: all trips, work trips and home-to-transit station trips (for those travelers using transit).

Supporters of TOD claim that a shift in the dominant land-use paradigm, from sprawling suburban tract housing toward greater density, pedestrian connections and transit accessibility, could produce important transportation benefits for cities and residents. These claims are based largely on data that show that residents of transit-oriented communities — be they new developments or older communities that fit the “transit-oriented” description — have a higher transit mode share, particularly for work trips, than residents of other communities, and have higher non-motorized mode shares for other trips (shopping, recreation, etc.) (Bernick and Cervero, 1997; Cervero, 1994). It is intuitive that those who live closer to transit are more likely to travel by transit than those who live further away. The data bear this out: in a study of seven suburban Bay Area communities, all with significant housing within 1/2 mile of the station, and all served by park-and-ride facilities, residents that lived within 1/2 mile of the station were between 5 and 7 times more likely to travel by transit than residents of the same communities, but outside of the 1/2 mile radius (Cervero, 1994). Pushkarev & Zupan (1977) demonstrate that residential density is also an important predictor of transit use. With other factors held constant, and assuming a CBD with a density of employment centers, these authors found that for every 10% increase in residential density (measured in units/acre), transit ridership increased by 6% (Pushkarev and Zupan, 1977).

Many of these researchers recognize that increases in transit use in transit-oriented communities must be attributed to factors outside of community land use. The critical determining factor for Pushkarev & Zupan, in determining the level of transit service that an urban area could support, is the total size of the downtown, in square feet of commercial space (Pushkarev and Zupan, 1977). Cervero (1994) showed that, for Bay Area residents living within 1/2 mile of a BART station, the availability of free parking at a person’s destination was the greatest predictor of whether that person would drive or take transit; Cervero estimated that the likelihood of taking transit increased by 40-50%, if parking at the destination was paid rather than free (Cervero, 1994). Regional factors such as the availability of free parking at destinations, and the size (in commercial area) of the downtown are largely beyond the control of TOD planners. But these factors are important concerns for regions trying to induce changes in travel behavior through the implementation of TOD.

Another critical factor in TOD residents’ use of transit was vehicle ownership per household: every available automobile caused the likelihood of traveling by transit to decline by about 10% — for 0–1 auto the value is somewhat above 10%, and declines
slowly for each marginal vehicle (Cervero, 1994). Strikingly, for a Bay Area resident within 1/2 mile of a transit station, the study found that if that resident owned 0 cars, worked in downtown San Francisco and did not have free parking at their destination, there was an 88% likelihood that residents would travel to work by transit. However if that same resident owned 3 cars, worked anywhere outside of the downtown, and had free parking available at work, that likelihood fell to less than 1% (Cervero, 1994). Residential parking requirements and other design elements of TOD zoning can have meaningful effects on residents’ travel behavior.

This data indicates that factors such as the availability of parking at destinations, and the overall square footage of commercial space downtown will likely have greater effects on regional transit usage than the proximity of housing to transit. Nevertheless, repeated studies do show that residents living within 1/2 mile of a transit station do often ride transit more frequently than residents further from the station — how much more depending on factors including those above, but also on community land-use diversity and design, and on the quality of transit service at the local station (Cervero, 2004).

### 1.3.2 Issues for TOD

Whatever TOD’s demonstrated or potential mode share impacts for station-area residents, it is out of scale with the problems urban areas face today, in that it cannot be implemented quickly on a wide scale. Without region-wide implementation, TOD’s benefits will be confined to a small group of high-income urban residents, and will not achieve meaningful changes in regional travel behavior.

It is a clear, but not often discussed, fact that any large-scale shift toward transit-oriented development will occur slowly, over many decades at least. The present form of our megaregions, and the tremendous amount of new and relatively young housing stock in suburban and outlying communities will be with us for fifty years or more. A greater issue than the building stock, in many places, would be the need for massive new rapid-transit service expansions. Fast growing areas in the South and West, cities such as Phoenix, Dallas, Atlanta and Las Vegas, would require service extensions magnitudes of scale larger than what exists currently, in order to extend service to residential areas and expand capacity to accept ridership increases. Even Northeastern cities with established subway and commuter rail systems would need major expansions, as most of these systems already operate at or near their designed capacities. The infrastructure and urban form changes required to enable widespread transit-oriented development will be costly, and will require decades to build.

But work cannot begin on these changes without another critical ingredient: consumer demand. Residential consumers must express strong preference for dense, transit-accessible communities, rather than the wide lawns and roadways of the typical suburban development. TOD proponents suggest that a greater demand exists for the benefits of dense, diverse, well-designed communities than most developers or others realize (Cervero, 1994). But urban form does not reflect this demand in U.S. cities, which, between 1990 and 2000 continued to grow in area more quickly than in population, allowing more and more space per person (Census, 2000). Not until American attitudes towards standards of community desirability change, and until this change is
demonstrated effectively to the development community and policymakers, will it be possible to beginning the work of implementing TOD on a scale sufficient to the challenges confronting our urban areas.

Transit-oriented development does not need to be the urban dominant form in order to have effects on VMT and air-quality, but targeted implementation of TOD in some cases raises issues of equity and exclusion. In so far as TOD design discourages driving in order to promote non-motorized and transit modes, it simultaneously restricts access to local amenities — including the local transit station — to those able to get there without a car. This poses problems for social equity and transit, as it excludes the majority of urban residents who live outside of a comfortable walking distance to transit and thereby restricts the pool of potential transit riders. These problems are exacerbated in situations where housing prices closest to the transit station are significantly greater than in less transit-accessible areas (as is the case in many cities with high-quality transit systems). In such cases, access to transit is restricted to those who are able to pay for it — in the form of higher housing costs — and often excludes those who are arguably in greatest need of transit services.

While some buyers are buyers are attracted to transit-oriented communities because of access to transit, many developers have sought to bolster this market by providing high-end furnishings and luxury amenities, and raising the cost of housing in these areas beyond the premium for transit accessibility. This problem is two-fold, in that it deepens the exclusion of lower- or middle-income groups from transit-accessible areas, while bringing into these areas the people who can most afford to (and therefore are the most likely to) drive. But as parking facilities are converted to high-end housing, and higher prices exclude more people from that housing, the impacts of that exclusion could pose significant negative impacts for regional transportation patterns and air-quality.

1.3.3 Climate Change and VMT

Global climate change is among the most significant challenges facing the world today. The transportation sector is the largest end-use and fastest-growing source of U.S. CO₂ emissions (EPA, 2006; E.I.A., 2006). Between 1990 and 2003, CO₂ emissions from the transportation sector grew from 1509.3 teragrams (Tg; 1 teragram is equivalent to 1 megatonne) to 1866.7 Tg, a 24% increase. As Figure 1.2 shows, despite anticipated fuel efficiency improvements, U.S. EPA estimates that transportation sector CO₂ emissions will continue to grow in the future, by 48% between 2003 and 2050 (EPA, 2006). This growth in transportation sector emissions is directly attributable to steep growth in VMT over the same period. Between 1980 and 2007, total U.S. VMT has increased at nearly three times the rate of population growth, and more than double the rate of new vehicle registrations (Reconnecting America, 2008). Growth in VMT is attributable to a variety of factors, but chief among them are today's sprawling pattern of development, relatively high per capita GDP and the consistent underpricing of driving-related resources (be they fuel, roadway space, parking, or others). If these trends continue, the 59% VMT growth between 2007 and 2030 will greatly surpass any gains in vehicle fuel efficiency technology (as the EPA model also predicts) (ibid.). Simultaneous to this sustained growth in VMT and transportation sector GHG emissions, cities, states and regions in the U.S. have begun to
take legislative action against climate change, by setting ambitious targets for the reduction of carbon emissions. Many of these target agreements call for overall reduction of carbon emissions (from all sectors) to 1990 levels by 2020, and to 60-80% below 1990 levels by 2050 as called for by the Intergovernmental Panel on Climate Change (IPCC, 2007). These targets — which according to scientific consensus are absolutely necessary to avoid crossing over an ecological tipping point, beyond which catastrophic changes are likely to occur — stand virtually no chance of being met, should current trends of VMT and associate emissions increases continue.

![Projected VMT vs. CO2](image)

Figure 1.2: Graph of projected VMT and vehicle-emitted CO2. (Source: American Public Transportation Association)

Despite increasing standards and technical efficiency gains, vehicle fuel technology is very unlikely to solve the problem of rising transportation sector emissions (Bandivedekar and Heywood, 2006). A VMT reduction solution is also necessary, in order for states and cities to meet their targets. TOD and park-and-ride both function as demand-side solutions to the emissions problem, by providing alternatives to the automobile and increasing VMT. Though they are both demand-side solutions, and both aim to shift commuters from their automobile into transit, TOD and park-and-ride are very different in how they accomplish this shift, their effectiveness in bringing about a shift in travel behavior, and the time and resources that they each require in order to effect such a shift.
1.3.4 Summary

Parking facilities at subway and commuter rail stations serve hundreds of thousands of commuters everyday, providing transit accessibility and an increased range of transportation choices to residents of suburban and rural communities. Park-and-ride likewise may offer cities a partial solution to traffic congestion, poor urban land use and decreasing air-quality. For transit agencies, station parking represents an opportunity to greatly expand potential ridership, making it possible to extend transit service despite low-density development patterns and high capital costs. But station parking is at best only partial and imperfect solution. Every park-and-ride user drove to reach the transit station, occupying road space and emitting local air-pollutants and greenhouse gases. Parking facilities are costly to provide and operate, and often hugely expensive to expand, and can create political tensions around facility siting.

Implemented as a stand-alone solution, park-and-ride facilities often fail to deliver on the benefits cited by their proponents – that this is true can be seen at under-utilized facilities in cities across the country, and the clogged roadways often within sight of these vast, empty lots. For park-and-ride to fully deliver the benefits it is capable of, it must be a part of a broader policy package aimed at ensuring that transit service can compete viably with driving and is not only the mode of those who cannot afford to drive. Where they are implemented well, these policies often include better approaches to parking (CBD capacity reductions, employee cash-out, smart pricing), and progressive ideas like roadway or congestion pricing, vehicle registration restrictions, and ‘feebates’ or more rigorous vehicle or fuel taxation systems, such as California’s Pavley Standards. Each one of these policy options provide an increased incentive for travelers to choose transit, an option that park-and-ride facilities are capable of extending to virtually all urban-area residents.

A number of transportation researchers and developers argue – many of them quite convincingly – that transit-oriented development presents a more complete solution to urban transportation, health and environmental problems. By housing people in direct proximity to transit, in walkable, comfortable communities, the automobile is removed from the home-to-station trip, without regulations or increased costs. Non-work trips, that in suburban communities often entail driving for several miles, can be converted to walk or bike trips, if the destination is located within the community, or to transit trips if it is elsewhere, not only reducing VMT and improving air-quality, but providing a more enjoyable, community-oriented city for residents to enjoy. But TOD’s potential is also its curse. The vision of a city remade to serve pedestrians, cyclists and transit passengers, rather than automobiles, is just that: a remade city. The cost in capital and natural resources required to retrofit and re-engineer our cities will be enormous, and the effort will take decades, even if we begin today.

How then should policy makers, developers and urban residents view these phenomena? Is park-and-ride merely a stop-gap measure whose obsolescence is now upon us? Is transit-oriented development a real solution to our cities’ problems, or merely a utopian vision, deployed by high-end developers? This author’s intuition, explored in this paper, is rather that park-and-ride and TOD are instead meaningfully different sorts of solutions, each capable of solving genuinely different types of problems. I will contend here that park-and-ride remains a viable option that is best used in certain places and under particular
policy conditions. It is not a one-size-fits-all solution, however, and transit-oriented development or other strategies may be more effective policy and development tools in many situations. Transit agencies, municipalities and their residents all have a stake in the choice of how to develop station-area land, and the land-uses that we choose should embody and support a set of goals for the local community and the larger region both.

Through a simulation involving data from Boston-area communities, this paper aims to show in concrete, measurable terms the benefits provided by transit station parking and TOD, in real communities. By comparing these benefits we may begin to better understand what is gained and what lost in the decision to develop station-area land for a particular use type. Finally, this paper hopes to shed some light on which use – parking or dense residential development – is better suited to different kinds of communities and why.
Chapter 2

Introduction to the Trade-offs Comparison Methodology

This chapter presents a basic two-part methodology to allow an apples-to-apples comparison of the potential regional travel effects of large-scale transit station parking and transit-oriented development. This methodology was used to estimate the demand for- and travel effects of park-and-ride capacity and transit-oriented development at commuter rail stations, based on a set of local and regional land use, demographic and travel indicators. The first part of the modeling methodology, the process aspect, estimates the amount demand for park-and-ride at a station. The second model component, the effects aspect, estimates the VMT reduction produced by the given level of demand at a particular station, and simulates in parallel the VMT reduction that might be achieved by instead converting station parking to TOD. Figure 2.1 presents the model outline in flowchart form.

One strength of this methodology is its flexibility. This generic method may be used to assess transit station land-use issues in regions and development contexts beyond the Boston case, where it is applied in this study. The generic methodology may also be adapted to a wide range of modeling and forecasting techniques, which may be applied at different stages in the methodology. The approach to the Boston case, presented in Chapter 4, employs fairly unsophisticated modeling techniques, but the basic methodology allows these to be adapted according to the data and modeling expertise available. This chapter lays out the three essential components of this generic methodology, and suggests some of the ways in these may be applied. Chapter 4 then presents one application of the methodology, to eight commuter rail stations in the Boston metro region.

2.1 Process Component: Methodology for Forecasting Demand for Park-and-Ride

The first component of the methodology is the demand forecasting. Rather than rely on existing data (if there is such data) for the overall number of park-and-ride users, or rate of park-and-ride use among travelers, which may be governed by existing capacity and fail to capture latent demand, this method employs land-use, demographic and travel indicators to estimate an expected demand value for a given station.
The essential form of the equation used to simulate the demand for park-and-ride (pD) service at a given station is:

\[ pD = W \times T \times Y \]

- Where \( W \) represents the total population within the catchment area,
- \( T \) represents the proportion of that population considered potential park-and-ride users,
- And \( Y \) represents the expected park-and-ride mode share among local CBD-bound commuters.

### 2.1.1 Station Selection

Selection of station cases may determine the applicability of the one’s study results. The generic methodology may be applied to any type of transit station (commuter rail, subway, bus, or multimodal), regardless of whether park-and-ride or TOD are present at the site. A number of factors may be considered in station selection, including geography, transit service type, surrounding land use, demographic and other factors, all of which may have
an impact on local demand for park-and-ride capacity. The range of factors considered in one's analysis will determine how widely generalizable the results of that analysis may be.

The approach in Chapter 4 presents a case study of eight commuter rail stations in the Boston metro region. The eight stations were chosen to represent the range of land use, geographic and demographic characteristics present across the MBTA commuter rail system, and the results of this case study are then applied to this system (see Chapters 4 and 6). A study with a more targeted application might choose only stations in a particular geographic area, or stations with a certain level of surrounding development density or level of transit service. On the other hand, a study seeking wider applicability might choose stations from beyond just a single region and transit system.

2.1.2 Catchment Area Definition

The second step is to define the region from within which a share of commuters may be expected to utilize a given park-and-ride facility — this is referred to as a station’s ridership catchment area. Park-and-ride users’ reported survey responses vary widely between studies conducted in California, Washington State, and Virginia. There is a degree of consensus in this literature that most park-and-ride users live within 10 miles of the facility that they use (Turnbull et al., 2004). There are, however, a number of complicating factors to this conclusion with relevance to park-and-ride demand forecasting: some studies report that park-and-ride facilities with highway accessibility draw users from a wider range than less-accessible facilities (Turnbull et al., 2004); commuters tend to be averse to driving away from their destination to access park-and-ride, showing a willingness to drive approximately twice as far to a facility that is in the direction of their destination (Wang et al., 2004).

Because catchment area definition will determine which communities and populations are included in the later forecasting steps, accuracy in determining the area boundaries is very important. The best technique available for this step would therefore integrate local park-and-ride user survey data, which could provide a very accurate picture of commuters’ willingness to drive to access transit. However, use of survey data depends on existing park-and-ride characteristics, including capacity availability (users will be less willing to drive if they worry about finding a parking space). Other techniques include setting a travel time or distance buffer from the station that may be expected to define commuters’ willingness to drive to access a facility (a travel time buffer is employed in the analysis of the Boston case in Chapter 4).

Accounting for Facility Competition

Where a park-and-ride facility catchment area encompasses more than one transit station, the shape of the catchment area (or one’s assumptions regarding commuting behavior within the catchment area) must be modified. This is an important step, and widely-adaptable to different modeling techniques. One may simply assume that park-and-ride users will utilize the facility nearest their home, and rule out all those residents nearer to another facility. More sophisticated techniques could involve a network accessibility model, to determine which facilities are most accessible from particular
communities. Another factor that might be considered is the available parking capacity at competing facilities, which might impact their potential to capture users.

2.1.3 Determining the Population of Potential Users

Once the facility catchment area has been defined, the next step is to determine the number of potential park-and-ride users within that zone. This step is directly related to the step that follows, setting a parameter for park-and-ride demand, and the approach to this step may determine (or be determined by) one's approach to the demand parameter. The approach to this step will also vary according to the scope of one's study: local conditions are less important in a nation-wide analysis, but the variation between two nearby communities may be critical to a study of a particular region.

The approach employed in the analysis of the Boston case, presented in Chapters 4 and 6, takes the number of workers with commute destinations in rapid transit-accessible areas as the potential park-and-ride user population. In the next step, this approach modifies regional mode share data to reflect this restriction of the eligible population. The choice to consider only the population of workers, rather than the total population within the catchment area, is motivated by park-and-ride's strong association with commute trips. In the U.S., 98% of park-and-ride trips are commute trips (Turnbull et al., 2004). Likewise, it made sense to consider as potential users only those commuters with destinations in rapid transit-accessible areas, as these destinations are the best served by commuter rail park-and-ride, in a radial system such as Boston has. However, for metro regions without a clearly-defined CBD, with multiple major employment centers, or exhibiting a different configuration of rail transit services, restricting eligible destinations to those within the CBD might make less sense (in fact, the approach employed in this study considers several peripheral areas, because of their employment levels and excellent transit service).

2.1.4 The Demand Parameter

The generic methodology presented here generates an expected demand for transit station parking capacity by integrating the number of potential users (defined in the previous step) and some expected share of park-and-ride trips. This share of commute trips that may be expected to utilize park-and-ride is referred to here as the demand parameter. As this value represents a share of the total commute trips, it will always be within 0 and 1.

The demand parameter may be defined in a number of ways. The simplest might be to borrow a value from other studies, in areas similar to one's own case study areas. A slightly more sophisticated approach might integrate data from other studies with expected impacts based on local conditions at case study stations. Local factors that might impact demand are wide-ranging: transit service characteristics, transportation network effects, and competing travel options are a few of these. Sophisticated techniques including discrete choice modeling and sensitivity analysis may be used to estimate commuters' demand for park-and-ride, and to adjust a baseline demand level according to local conditions. Approaches to this step in the methodology may therefore range widely according to the tools and modeling expertise available.
2.1.5 Estimating Demand for Park-and-Ride Capacity

Following the simple equation shown in §2.1 above, multiplying the number of potential users of park-and-ride by the expected park-and-ride trip share (the demand parameter) will generate an estimated level of demand for park-and-ride capacity at a given transit station. Many different techniques may be employed to generate values for potential users and park-and-ride trip share, but this last step of the forecasting component applies for all of these.

2.1.6 TOD Development Size

This methodology allows for many different approaches to the choice of how much land area at transit stations should be considered available to TOD. These approaches and the assumptions that underlie them will have a determining effect on the results of the comparison between TOD and park-and-ride. If the land area available to TOD is assumed to be highly constrained — to the existing parking lot area, as in Chapter 4 — TOD’s travel effects are bound be more limited than than under the assumption that TOD might come to occupy the entire land area in a 1/2-mile radius around the transit station.

The approach presented in Chapter 4 assumes that only the land currently in use as commuter parking is available to TOD, so as to compare the travel effects of TOD and park-and-ride, given equal land area. While this seems a useful way to think of the comparison, it likely not the best, and surely not the only way to go about it.

2.2 Impact Component: Methodology for Estimating the VMT Effects of Park-and-Ride & TOD

The impact component of the comparative methodology is rather straightforward relative to the process component. Employing the logic of a basic trip model, and using the park-and-ride demand and TOD availability values from the process methodology, one can easily calculate the impacts of park-and-ride and TOD on commute-generated VMT.

2.2.1 Estimating the Impact of Park-and-Ride on Commute VMT

Essentially, the VMT impact of a set amount of park-and-ride capacity will be equal to the amount of capacity multiplied by each park-and-ride user’s foregone commute distance, minus the distance that each user drove to the transit station. One critical assumption involved in this step involves the rate at which it is assumed that park-and-ride trips will replace drive-alone trips (as opposed to carpool or other transit trips). The assumed rate of drive-alone trip replacement will have a significant impact on the net VMT result. If local data is available on the rate at which replacement occurs, that data should be integrated with the VMT calculation.
Calculating Gross VMT Reduced: Commute Distance

There are a number of ways in which to calculate the commute-trip distance foregone by each park-and-ride user. GIS and other mapping software and techniques allow this calculation to be made with great accuracy. Simpler approaches to estimating the commute distance might involve taking the driving distance between the transit station and the CBD as the average commute distance for catchment area residents (assuming an even distribution of users around the transit station, this might be the case). Still other techniques are surely available.

Calculating VMT Generated: Station Trip Distance

Because park-and-ride necessarily involves an auto trip, its net effect on VMT must be somewhat less than the total distance of users’ foregone commute trips. How much less will vary according to the distance that each park-and-ride user must drive to access the transit station. As with the commute-trip distance, above, there are a number of ways to calculate the station trip distance. The technique elected here may be influenced by the manner in which the catchment area was defined, in the process methodology, above. If a constant catchment area is assumed for all stations, it makes sense to assume a constant station trip distance. However, if a travel-time or accessibility buffer was used to generate irregular and non-constant catchment areas, then a constant station trip distance makes little sense.

A more sophisticated technique might employ GIS to generate straight-line or driving distances between groups of residences transit station, in order to find an average trip distance that will be unique for each catchment area.

2.2.2 Estimating the Impact of TOD on Commute VMT

Much like the VMT impact calculation for park-and-ride, the method for estimating the VMT effects of TOD are mathematically very basic, but it involves a critical methodological choice: how to consider the non-commute trip effects of TOD. Putting this concern aside for a moment, the calculation works essentially as follows: the number of travelers in the TOD multiplied by TOD’s transit-inducing effect, the number of trips per day, and the distance of each forgone auto trip. Each of these components is discussed in turn below.

- Traveling population — Depending on whether or not one’s model accounts for TOD’s non-commute effects, it may also account for all or only a portion of the total population of a TOD. For a model considering only the commute-trip effects, only residents that are commuting workers should be considered.

- Transit-inducing effect — Using local survey data, discrete choice techniques, borrowing from the literature, or another method, one must assume a value for TOD residents’ share of trips that are made by transit. Comparison with the current transit mode-share in the community (if TOD is not present there currently) will reveal the degree to which, in terms of mode share, TOD shifts residents’ trips to transit.
• Trip distance — This value represents the average distance of each commute trip. This may be more or less difficult to calculate depending on one’s assumptions, as well as on CBD size and transit network structure (e.g. for the Boston region, with a large employment center in the CBD and a radial transit network, one might assume that the average trip distance is approximately equal to the distance between the TOD and the CBD).

Non-Commute Trip Effects of TOD

Unlike park-and-ride, which is limited to commute trips, TOD is likely to have effects on most or all of a resident’s trips. Limiting one’s TOD impact model to capture only the impact on commute trips, then, disadvantages TOD relative to park-and-ride within the comparison. But whereas capturing TOD’s impact on commute-trip VMT is fairly straightforward, modeling its impacts on all trips is less so, and must involve assumptions about the diversity of uses within the community (that residents might walk to), as well as about the transit accessibility of other resources and amenities region-wide.

The approach presented in Chapter 4 chooses to limit consideration of TOD’s travel effects to commute-trips only, within the methodology. Non-commute travel benefits receive discussion, but no quantitative data is presented. This is not ideal, however, and future research into this area would do well to suggest a suitable model for the wider travel effects of TOD.

2.3 Performance Metrics

Some metrics on the basis of which park-and-ride and TOD performance may best be evaluated include net VMT reduction, the cost-efficiency of that reduction (opportunity cost per vehicle mile reduced), and the per-parking space efficiency of VMT reduction. These metrics may each have more or less appeal depending on the audience, but each one captures an essential component of land use performance in this case. These three are offered because they convey valuable information in an accessible, usable way.

Net VMT Reduced

Overall VMT reduction, regardless of cost or land area, is an important performance metric, may be the best metric for making the comparison between park-and-ride and TOD, as it gets right to one of the central benefits that we expect from each land use (though, as discussed above, this may represent only a portion of the benefits provided by TOD). This metric may have particular value for those concerned with traffic congestion, urban air quality, or climate change, as VMT reductions may be tied directly to improvements on each of those issues.

This metric may also be more useful when applied system-wide than between stations. Cost- and space-effectiveness do a better job of distinguishing performance from among park-and-ride facilities, whereas overall VMT reduction may provide audiences with a picture of overall system performance, for instance allowing for the comparison of the net VMT reduction produced by park-and-ride system-wide to total regional VMT.
Chapter 2. Introduction to the Trade-offs Comparison Methodology

Cost Efficiency

Cost is a major concern for transit agencies; the MBTA currently operates with an annual deficit of nearly $400 million (The Boston Globe, 10/17/2007). As most U.S. transit agencies operate with significant public subsidy, the cost-efficiency of transit operations may also be considered a subject of interest to the public. For these reasons, and because park-and-ride facilities are owned largely by transit agencies, cost-effectiveness is a meaningful indicator of park-and-ride performance.

Taking the annual opportunity cost of providing land for park-and-ride, and dividing by the yearly VMT reduction achieved by park-and-ride on that site (daily VMT reduction x 260 workdays per year) provides the cost per vehicle mile reduced ($/VMT reduced). This metric integrates the benefit and the greatest cost of providing park-and-ride, in a result that may be used to compare between station facilities. In a case in which facility cost performance is relatively constant among facilities, this metric may be of little use to anyone but diehard opponents of park-and-ride. However, in among stations that exhibit significant variability in cost-effectiveness, this metric may be of use to transit agency officials or others interested in optimizing performance system-wide, through targeted facility expansions and closures.

Space Efficiency

VMT reduced per parking space may be a third useful metric with which to evaluate park-and-ride performance. The land area invested in each parking space is something of value, both to the transit agency that owns the space, and the public that might rather see the space developed as a shopping mall. Mostly, though, this metric breaks the overall benefit down by a concise, understandable unit, and provides an accessible tool for thinking about park-and-ride performance.
Chapter 3

Boston Case Background: Transit System Service and History

3.1 Transit in Boston: MBTA System Overview

The Massachusetts Bay Transportation Authority (MBTA) manages and operates subway, light rail, commuter rail, bus and ferry services in the Boston region. In 2006, total MBTA system ridership averaged 1.1 million riders per weekday; 598,200 of these riders used the subway or light rail (MBTA, 2006). According to the 2000 Census, 15% of residents of the Boston region commuted to work via some form of transit, up slightly from 1990 (C.T.P.S., 2005). 55% of work trips, and 42% of all trips into downtown Boston are by transit (C.T.P.S., 2005).

Figure 3.1 provides a map of the MBTA subway system. The MBTA rapid transit system (subway and light rail) is made up of 125 stations and 65.5 miles of track on 4 lines,
serving Boston and portions of several surrounding communities. The system connects a number of nearby communities to one another and to downtown Boston, including Cambridge, Somerville, Chelsea, Revere, Quincy, Brookline, Newton and others. More distant suburbs and towns are served by the MBTA commuter rail system, which connects to the rapid transit system at 4 points: Porter Square station and South station on the Red Line, as well as Back Bay station and North Station on the Orange and Green Lines, respectively.

The MBTA operates commuter rail service to 123 stations in suburban centers and towns across the region. 12 lines stretch North, South and West from Boston in a radial pattern – 3 lines have branches, and a fourth branch provides service to Gillette Stadium during events (see Figure 3.2). Weekday boardings on the commuter rail in 2002 and 2003 averaged 141,160/day (C.T.P.S., 2005). Commuter rail lines connect major Boston rapid transit stations to outlying suburbs and towns, and most lines terminate at or near larger cities with significant commuting populations. Many older cities in the region are served by MBTA commuter rail, including Lowell, Lawrence, Gloucester, Salem, Lynn, and Fitchburg. Large suburban centers with commuter rail stations also include Framingham, Dedham, Brockton and Waltham, among others (see Figure 3.2).

![Figure 3.2: MBTA commuter rail service map (source: MBTA.com)](image)

The MBTA remains committed to commuter rail service expansion, despite a number of widely-publicized service-quality setbacks in recent years. The Greenbush commuter rail
3.1. Transit in Boston: MBTA System Overview

Line began service in October 2007, bringing rail transit to a number of cities and towns on the South Shore. A further system expansion, to bring service to the cities of Fall River and New Bedford, is in the planning stages, and has the strong support of the current governor.

3.1.1 Park-and-Ride in Boston, Currently

Figure 3.3 shows the sites and utilization rates for all parking facilities at MBTA commuter rail stations. The 46,000 MBTA-owned parking spaces at rail transit stations in the Boston region (there are approximately 8,000 more on municipally-owned land) exceed the total parking capacity of downtown Boston (Arnott, 2006). There are 136 park-and-ride facilities located at MBTA rail stations, 107 at commuter rail stations (with total parking capacity for 31,400 vehicles), and 29 at rapid transit stations (14,600 space capacity) (C.T.P.S., 2005). More than half of the 46,000 total MBTA-owned station-area parking spaces are at large, freeway-accessible, multi-modal facilities (C.T.P.S., 2005).

While park-and-ride is not a travel mode captured by the Census or other major surveys, CTPS and the Boston MPO track utilization rates for rapid-transit and commuter rail station parking facilities, on a 5-year cycle. Observations in 2006 and 2007 showed that 63 commuter rail parking facilities (59% of total) typically fill to >85% of capacity; 16 parking facilities at rapid transit stations (55%) also fill daily (C.T.P.S., 2005). For the most part, utilization rates in 2006-2007 are slightly below their 2002-2003 values, though this is to be expected, due to capacity increases at a number of stations during the intervening period (C.T.P.S., 2005).

CTPS reports that in general, stations further from downtown Boston, and stations with direct freeway access show better utilization than stations nearer to downtown and/or without direct freeway access (C.T.P.S., 2005). Greater utilization rates at more distant facilities is likely explained by a number of factors, most importantly that these areas are without competing transit services to downtown Boston, and development densities are quite low near many more distant stations, and few residents live within walking distance of the station. Another possible explanation for this phenomenon, is that many of the more distant facilities are relatively small, in comparison with much larger facilities within or adjacent to Rte 128. It is difficult to know whether high utilization at more distant facilities is a reflection of unmet demand for station parking further from Boston. Though unable to adequately address this question, this paper presents a methodology that suggests that unmet demand for parking may be a factor at some stations.

Freeway accessibility has a two-part function in attracting park-and-ride users: because of faster travel speeds it expands a station's ridership catchment area – the area from within which commuters are most willing to drive to station parking – creating a larger pool of potential users. Second, freeway access is the best form of advertising for park-and-ride facilities. The majority of commuters using station parking at rail stations in the U.S. learned about the facility they use by seeing it from their car (Cervero, 2004).
Figure 3.3: Map of MBTA park-and-ride facilities and utilization (Source: C.T.P.S.)
3.2 Transit & Parking in Boston, History

Chartered in 1830, the Boston & Lowell Railroad, the first major railroad in Massachusetts connected Boston to the important textile center to the Northeast. This began a period of major inter-city railroad construction throughout Massachusetts, that saw the completion of four additional lines to cities throughout the region in just 12 years. This railroad network, continually expanded for much of the next hundred years, today makes up virtually all of the MBTA commuter rail system (MBTA, 2006).

The Tremont Street subway, opened in Boston in 1897, was the first subway North America, though it was quickly surpassed in scale by the New York City subway, one year later. Much of the current MBTA subway system was completed by 1912, though that system would be extended, tunnels widened and platforms lengthened repeatedly over the following decades, continuing through the present.

Like many other large U.S. urban areas, the Boston region saw large-scale expansion of park-and-ride services during the 1980s and '90s. The first large transit station parking facility was built in 1975 by the Massachusetts Bay Transportation Authority at Wellington station, on the Orange Line subway. The surface parking lot had a capacity of 1,516 spaces, which greatly exceeded any other MBTA facilities at that time. Braintree station, on the Red Line subway and built in 1980, included a park-and-ride facility with capacity for 1,200 automobiles; like at Wellington all parking capacity was in a single surface parking lot.

In 1991, the MBTA operated more than 16,000 park-and-ride spaces in the Boston region. By 2004, that number had grown to 46,000, a capacity increase of almost 200% in 16 years (C.T.P.S., 2005). 31,400 of these spaces serve commuter rail stations — mostly in low-density towns and suburban areas — with the other 14,600 at subway stations on the outskirts of the urban area (MBTA, 2008). Utilization levels vary widely between facilities (Ron Morgan, personal communication), from very high (greater than 100% utilization, possible because of vehicle turnover) at many of the largest facilities — at both subway and commuter rail stations — to relatively low (50% or less) at a number of smaller lots, all of which serve commuter rail stations.

Much of the Boston region’s park-and-ride expansion in last seventeen years is directly attributable to another highway project, the Central Artery project, otherwise known as "The Big Dig". Because Boston and many of the surrounding cities and towns are in non-attainment of EPA air-quality standards, the Central Artery project was required to provide measures to mitigate the effects of any new auto traffic that it expected to generate. Central Artery mitigation measures include the extension of several transit lines within the urban area, a commuter rail expansion, and 20,000 new park-and-ride spaces at transit stations (this number was increased to 21,000 following a court settlement between the MBTA, State Executive Office of Transportation (EOT), and the Conservation Law Foundation (CLF), after CLF brought suit that the MBTA and EOT had failed to adhere to mitigation requirements) the last of which were completed in 2003 (Ron Morgan, personal communication). Additional capacity was added through the TIP (an federally-required regional transportation planning process) while other facilities were opened or expanded by the MBTA because of requests from cities and towns within the region, or because of significant unmet demand for parking at existing facilities or stations. In the Boston
region the TIP and EPA non-attainment mitigation strategies have proven to be important mechanisms in the development of park-and-ride, from a small-scale community service to a region-wide TDM measure.

Summary
Transit station parking is most needed in low-density suburban and rural areas, which also contribute disproportionately to regional VMT. In many cases, these are the same areas with the greatest potential for TOD, both in terms of positive neighborhood effects and effects on travel behavior. Rather than consider all types of rapid transit stations, then, this study focuses only on stations served exclusively by the MBTA commuter rail. A number of these stations are in urban areas, just outside of Boston proper. Many others lie in the suburban communities that surround the urban area, or in the small town centers beyond those. All of these station types are considered in this study, in an effort to provide results that are valid and generalizable throughout the Boston region.
Chapter 4

Application of the Tradeoff Comparison Methodology to the Boston Case

This study employs a basic travel and demand simulation to estimate the demand for, and the travel effects of, parking at transit stations. The simulation was conducted for eight commuter rail stations in the Boston region, drawing on current transit service, land use, and demographic data particular to each station. The goal was to predict demand for parking at that station and to estimate the impact that parking demand, if met, might have on regional travel (in VMT reduced per trip or per day).

Of the eight stations included in the study, the simulation generated levels of demand for station parking below the actual parking capacity at four stations (Norwood, South Weymouth, Stoughton, West Natick), and demand above current capacity (though not necessarily above latent demand) at four stations (Lynn, Shirley, West Medford, Wilmington; for details see Figure 5.2).

4.1 Estimating the VMT Reduction Effect of Park-and-Ride at Case Study Stations

Case study selection

Eight Boston-area stations, all served by the MBTA commuter rail and containing some amount of parking capacity, were selected as case studies for the simulation. Case study stations were chosen according to surrounding development type, distance from the CBD, and demographic factors. The number of cases and choice of particular stations was done so as to include 2 or more instances of each characteristic's expression (e.g. 2 stations are within 10 miles of the CBD, 3 stations are 10-20 miles from the CBD, 3 stations 20+ miles from the CBD). This was done so that the results would be generalizable across the MBTA commuter rail system. Prior to selection, candidate stations were typed according to a basic land-use typology: each station is considered either low-density, suburban center, or urban area, according to the population density of the surrounding community (similar to station typology presented in Cervero, 2001). This study includes at least two stations from each land-use type. These are shown in Figure 4.1.
Figure 4.1: Map of case study stations & catchment areas

<table>
<thead>
<tr>
<th>Station</th>
<th>Type</th>
<th>Density (persons/acre)</th>
<th>Distance from CBD (miles)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shirley</td>
<td>Low density</td>
<td>.5</td>
<td>54.4</td>
</tr>
<tr>
<td>S. Weymouth</td>
<td>Low density</td>
<td>3.3</td>
<td>17.6</td>
</tr>
<tr>
<td>Stoughton</td>
<td>Low density</td>
<td>3.1</td>
<td>20</td>
</tr>
<tr>
<td>Wilmington</td>
<td>Low density</td>
<td>3.0</td>
<td>17.1</td>
</tr>
<tr>
<td>Norwood</td>
<td>Suburban center</td>
<td>4.5</td>
<td>22.4</td>
</tr>
<tr>
<td>W. Natick</td>
<td>Suburban center</td>
<td>6.5</td>
<td>22.6</td>
</tr>
<tr>
<td>Lynn</td>
<td>Urban area</td>
<td>17.2</td>
<td>10</td>
</tr>
<tr>
<td>W. Medford</td>
<td>Urban area</td>
<td>16.5</td>
<td>6.6</td>
</tr>
</tbody>
</table>

Table 4.1: Summary of case study stations
4.1. Estimating the VMT Reduction Effect of Park-and-Ride at Case Study Stations

The eight stations also represent 7 of the 12 MBTA commuter rail lines (including branches), and provides a fair geographic and demographic representation of the Boston metro region.

Determining Catchment Area Size

For each of the eight case study stations, a ridership catchment area (see §2.1.2) was estimated, using the Network Analysis function in GIS. Most studies of station parking accessibility describe catchment areas according to distance from the station (Cervero, 2004). For this simulation, travel time, rather than distance, was used to define the catchment area shape. Defining the catchment area this way, according to travel time, better accounts for varying roadway accessibility conditions in the station environs.

The GIS Network Analysis function estimates station accessibility using a set travel time buffer, and design speeds of nearby roadways. This accounts poorly for traffic congestion, so different travel time buffers were used, according to station type (see Table 4.1). A 10-minute buffer was used for low-density stations, 8 minutes for suburban center stations, and 5 minutes for urban area stations. As one would expect, estimated catchment areas for the eight case study stations are irregularly shaped, extending further along arterial roads and highways than on smaller local roads (see Figures 4.1-4.9, below).

Catchment area projections were then overlaid on a census tract map (the smallest area unit at which demographic and origin-destination data were available), and all census tracts with at least 50% overlap with the catchment area were accepted. Other nearby transit stations were then added to the map, and noted as containing parking or not (amount of parking at any station was not accounted for). Any tract initially considered to be within a station’s catchment area, that was nearer to another station with parking was withdrawn from the catchment area of the station under consideration. When ‘nearer’ was difficult to determine, higher-definition residential density data was used to make this determination (for a detailed description of this data see §4.1). Also, any tract initially a part of a station’s catchment area that contains within the tract a station without parking was withdrawn from the catchment area of the station under consideration.

Determining Home-to-Station Trip Distance

To estimate the average home-to-station trip made by all park-and-ride users to each of the eight case study stations, this approach mapped a high-definition residential density projection onto the eight catchment areas, and determined their straight-line distances from the stations. The data source was a 250-square meter grid cell projection of residential densities, compiled by M.A.P.C., and it provided a much more fine-grained view than the census-tract data. For each catchment area, all grid cells with any non-zero number of residents were mapped, and their straight-line distances to the station were measured, using the Spatial Analyst function in GIS. These distances were then averaged, within each catchment area, the resulting value being the average home-to-station trip distance for that catchment area.

This approach was methodologically limited in two ways: straight line distance is in some cases a poor representation of the actual driving distance between home and
station, and counting all grid cells with any non-zero residential population fails to account for variations in population density within the catchment area. More advanced analysis techniques should be explored, in any future research into this topic, in order to better represent the home-to-station trip.

**Estimating the Number of Potential Park-and-Ride Users**

Population size and travel destination data were collected for each census tract within the eight station catchment areas. Total population was adjusted in order to estimate the number of workers within each catchment area, by multiplying the total population by the Boston-Lawrence-Worcester metro region average employment rate (53%, source: Census 2000). This approach assumes that non-workers make zero commute trips each day, while workers make 2 commute trips per day (home-to-work, work-to-home).

The Census Transportation Planning Package (fhwa.dot.gov/ctpp) publishes a complete tract-to-tract origin destination (O-D) survey, from which the O-D results for residents of each census tract corresponding to a station catchment area were collected. Destination tracts were classified as either ‘transit-served’ or ‘not transit-served’, according to the availability of rapid transit service in that tract. In this approach, transit service serves as a kind of proxy for the CBD. For data management purposes, all of Suffolk County (corresponding closely to the city of Boston boundaries), and a relatively small number of tracts in Middlesex County (corresponding to those parts of Cambridge and Somerville served by the MBTA Red Line subway), were considered to be transit-served. All other census tracts were considered not transit-served. The number of commuters to transit-served areas, and the proportion relative to the total number of commuters, was recorded for each tract within a catchment area. These values were then aggregated to the catchment area-level, to show the overall proportion of commuters to transit-served areas, for each of the eight station catchment areas.

The total number of workers in a catchment area was multiplied by the overall proportion of commuters to transit-served destinations, to generate the number of potential park-and-ride users within a given station catchment area.

**Determining the Level of Demand for Park-and-Ride**

Household survey data from the New York City and Boston metropolitan areas shows that 9.6% of transit trips originating from communities within the Boston region, and 10.9% of transit trips from within the greater New York City region reportedly utilize commuter rail. Combining these figures with overall transit mode shares for these regions (11.7% for Boston, 22.4% for New York; source: CTPS 2007, NYMTC 2006) overall commuter rail mode shares may be estimated. These data indicate that 1.1% of all Boston-region trips are made by commuter rail, and 2.4% of New York region trips. Taken together, and weighted by the household survey sample sizes, the data for both regions indicate that 2.1% of trips taken in these two regions go by commuter rail. Of these commuter rail trips, 80% (75% of Boston-region trips, 82% of NY-region trips) were considered intermodal trips. The survey considered a trip to be inter-modal if it began with auto-driver, auto-passenger, or bus modes for station access trips; non-motorized modes of station-access (e.g. walking,
bicycling) were not counted as inter-modal. A subset of this survey data shows that greater than 80% of these inter-modal trips were made by park-and-ride (as opposed to bus-and-ride or kiss-and-ride).

This approach to the Boston case assumes that 8.4% of residents within a station catchment area and commuting to transit-served destinations, will travel to work via commuter rail. The overall trip mode share for park-and-ride (2.1%) was multiplied by a factor of 4, to account for the exclusion of all non-CBD bound catchment area commuters. Further, this approach assumed that an 80% share of commuter rail trips are by park-and-ride. Taken together, this analysis assumes a baseline demand parameter of .067 for park-and-ride, among station catchment area residents with transit-served commute destinations. That is, 6.7% of all potential park-and-ride users (those who live near a station and commute to a rail transit-served destination) are assumed to actually use it on a given day.

**Local Factors and Demand Sensitivity**

This approach assumes that baseline demand will be adjusted by a number of local station factors, including the cost and travel time of commuter rail service (at a particular station) relative to driving, as detailed below:

- **Cost** The cost of taking transit includes the cost of a one-way commuter-rail ticket from the origin station to the terminal station in downtown Boston (North or South Station, depending on the line), and the cost of parking for one day at the origin station. This cost is compared to the estimated cost of driving from the origin station to the respective terminal station (representing a proxy for a destination in downtown Boston). The cost of driving is assumed to be $.14/mile, representing the cost of fuel, maintenance and tolls or fees (but not vehicle value depreciation), plus an additional $3/day for parking at the destination. If the cost of transit is less than or equal to the cost of driving, the demand parameter receives a bonus of +.005. If the cost of transit is greater than 150% of the cost of driving, the demand parameter receives a penalty of -.005. If the cost of transit lies between 101% and 150% of the cost of driving, there is no effect on the demand parameter. If the cost of transit is greater than 150% the cost of driving, the demand parameter is adjusted downward by .005.

- **Travel Time** Travel time by transit accounts for only the time between the origin station and North or South Station, in downtown Boston, and is provided by MBTA commuter rail schedules. This value is compared to the travel time by driving, between the same origin and destination (as a proxy for the commute trip). Drive time is calculated by taking the average of values generated by both the 'best route' network analysis tool in GIS, and using Google Maps' drive time calculator. However, both the GIS and Google travel time calculations appear, after repeated testing, to under-represent actual travel times. For this reason, when travel time by transit from any station is less than or equal to 125% of that station's respective travel time by auto, that station receives a +.005 bonus to its demand parameter. Where travel time by transit is greater than 175% of the travel time by auto, that station receives a demand penalty of -.005.
Another service characteristic that is reportedly important to park-and-ride users is service frequency, which this approach takes to be the number of trains serving a station during morning travel hours. However, within the MBTA commuter rail system, there is very little variation between stations for this characteristic, so it is not included as a demand-adjustment factor.

The +/- .005 demand adjustment may not be reflective of actual user perceptions of these transit service characteristics. A sensitivity analysis of rider behavior could be used, in the future, to better calibrate the model for local service effects.

**Estimating Demand for Park-and-Ride at Case Study Stations**

Finally, to estimate total demand for parking at the eight case study stations, the total number of potential park-and-ride users was multiplied by the adjusted demand level. The resulting values (see Table 5.2) represent the expected numbers of park-and-ride users for each case study station, on any given weekday.

**Estimating the VMT Reduction Effect of Expected Park-and-Ride Demand**

The second step in the VMT estimation methodology was to estimate the amount of VMT reduction that would be produced by the amount of park-and-ride capacity predicted for each station by the steps detailed above. This approach assumes that every park-and-ride trip replaces a drive-alone commute trip, each with the same destination. Essentially, this involves the replacement of the home-to-CBD trip with the home-to-station trip. The net VMT effect of this substitution was found by calculating the amount of VMT generated (by home-to-station trips) by a given amount of park-and-ride capacity, and subtracting this value from the amount of VMT reduced (by foregone home-to-CBD trips).

Home-to-station trip distance is discussed above, in §4.1. The foregone home-to-work trip distance was found by taking the average of the values generated by the route analyst tool in GIS and Google Maps’ route finder tool. Subtracting VMT generated from VMT reduced provided the net VMT effect per parking space at a given station. Multiplying this value by the estimated demand for park-and-ride spaces (see above) provided the net VMT reduced by park-and-ride at a case study station.

**Determining the Performance Metrics**

The metrics used in this approach to assess the performance of park-and-ride at the eight case study stations are cost-effectiveness and space-effectiveness, described in detail below:

- Cost effectiveness is counted as the dollar cost per yearly VMT reduced by commuter rail park-and-ride. The MBTA manages its park-and-ride lots such that the revenue generated from parking fees roughly offsets lot development and maintenance costs, system-wide. For surface parking lots, which make up virtually all MBTA commuter rail park-and-ride facilities, lot development and operation costs — even without the offsetting fee revenue — are outweighed by the opportunity cost of the land: the annual income that the MBTA is foregoing, in choosing to use the land as commuter parking rather than develop it for more intensive uses.
4.1. Estimating the VMT Reduction Effect of Park-and-Ride at Case Study Stations

The approach used in the analysis of the eight Boston region stations does not consider operations and maintenance costs, nor fee revenue, in its assessment of facility cost-effectiveness. Rather, that facility’s yearly VMT reduction is weighed against the annualized revenue-generating potential of the land it occupies. The result is a cost-effectiveness metric in the form of (opportunity-) cost per yearly VMT reduced.

The rent-generating potential of parking lot land was established using quarterly (Fall 2007) real estate rent averages, for office and retail space (Research, 2007a,b). Beginning with the average per-square-foot annual value of land in the metro region, a simple rent-gradient was applied to this value, to estimate the value-diminishing effect of distance from the CBD. The gradient assumed that properties 0-5 miles from the CBD generate 100% of the listed value, 5-10 miles 85% of listed value, 10-20 miles 75% of listed value, and 20+ miles generated rents at 65% of the listed value. Parking lot area was estimated by taking the number of parking spaces in the lot, and assuming 275 square feet of area per parking space — including all vehicle access-ways and other non-parking space. The annual rent-generating potential value of each square foot of land was then applied to the total parking lot square footage, to estimate the yearly opportunity cost of using that land for commuter parking.

- The space-effectiveness metric simply takes the daily net VMT reduction provided by a park-and-ride lot, and divides that by the total number of parking spaces in the lot. The resulting value reflects the VMT reduction per commuter at that facility.

4.1.1 Estimating the VMT Reduction Effect of TOD at Case Study Stations

The approach employed for the Boston case study stations estimates TOD’s effect on VMT through assumptions about its effects on residential density and transit mode share. TOD entails a complete vision for community design, and as such, TOD could be expected to have a host of effects and consequences for the local station-area community. The approach employed for the eight case study stations is a view of TOD “from 30,000 feet”. It is well beyond the scope of this project to attempt to genuinely and adequately simulate the wide-ranging and inter-related effects that transit-oriented development might have on regional travel patterns (though this is a promising area for future research). This approach reduces TOD to its impacts on two critical variables: population density and transit mode share.

As is discussed above in §1.3.2, it is clear from the literature that residential transit-oriented development is only one factor – perhaps not even the most significant factor – in commuters’ choice of travel modes (Cervero, 2004). Other critical factors include the availability of free parking at the destination, the size of the downtown, and vehicle ownership levels. The basic approach employed here does not account for any of these factors, seeking to isolate and express only the effects of increased density and pedestrian-oriented design at the residential trip-end on travel patterns.
The Impact of TOD on Residential Density

This approach assumes that TOD has a varying density effect, according to station type. A density of 12 dwelling units per acre is assumed for TOD at low-density stations, 16 d.u./acre at suburban center stations, and 20 d.u./acre at urban-area stations. This density was applied only to the land currently used as commuter parking at a given station (e.g. The size of the parking lot at Stoughton CRR station is 3.44 acres; at 16 d.u./acre, this approach assumes that TOD at Stoughton includes 55 new residential units).

This approach assumes 2.6 residents per dwelling unit, and a 53% rate of employment among all TOD residents (source: Census 2000). Employed residents are assumed to make 2 commute-trips per day (weekdays only), and non-workers are assumed to make 0 commute trips. Non-commuting VMT was not accounted for.

TOD’s Impact on Journey-to-Work Mode Share

Existing transit and drive-alone mode shares for station areas were taken from 2000 census data. Initial station type has no effect on the resulting station area mode split under TOD. Transit and drive-alone mode shares are both constant values for all station-areas, regardless of station type.

There are reported cases of transit-oriented developments located adjacent to commuter rail services in Chicago, Portland, and Philadelphia, that show a very large share of residents’ trips taken by transit (as high as 65%) (Metra 2004). However, this approach borrows the results from a widely-conducted household survey of three large TODs, located near commuter rail stations in California, which found a transit mode share of 17% for TOD residents (Cervero, 2004). This approach assumes this 17% commuter rail mode share for all commute trips made by residents of transit-oriented developments at MBTA commuter rail stations. The current journey-to-work commuter rail mode share reported by the station community (Source: Census 2000) is then subtracted from the assumed 17% TOD mode share, to produce the mode shift impact of TOD at that station (e.g. the current commuter rail mode share for Stoughton is 6.4%, so the mode shift impact of TOD at Stoughton is 11.4%).

As this study is concerned only with commuter rail stations where other transit modes are typically scarce and non-motorized commuting mode shares are often low, this approach assumes that all new transit trips replace former drive-alone trips (so the 11.4% increase in commuter rail trips at Stoughton is paralleled by a 11.4% decrease in drive alone trips). Non-commuter rail transit and non-motorized mode shares are assumed to remain constant under TOD. Within this simulation, all growth in transit mode share is directly attributable to a reciprocal decrease of drive-alone mode share, as a result of TOD’s increased residential density and transit-focused design.

Estimating the Overall VMT Effect of TOD at Case Study Stations

The impact of TOD on commute-generated VMT at the eight Boston region case study stations, as it is estimated in this approach, assumes that under-non TOD conditions, an equal number of dwelling units would be developed elsewhere in the community, with journey-to-work mode share similar to that currently exhibited in that community.
4.1. Estimating the VMT Reduction Effect of Park-and-Ride at Case Study Stations

Commute-generated VMT was then calculated, using the number of workers (the same for both TOD and non-TOD conditions) and the station distance from the CBD (again assumed to be the destination for all commuters). Subtracting the value for commute-generated VMT under TOD conditions (higher commuter rail and lower drive alone mode shares) from the value under non-TOD conditions (higher drive-alone mode share) isolated the impact of TOD on commuting VMT.

4.1.2 Limitations of the Operational Method Employed in Analysis of the Boston Case

There are a number of limitations to the approach to estimating and comparing the VMT reduction effects of park-and-ride and TOD described above.

- The attribution of a baseline level of demand for park-and-ride relies on a number of assumptions about traveler behavior, and on out-dated and partly non-local survey data. Future research into this area would be aided by better household travel survey data for the Boston region. Lacking this, a thorough discrete choice model might be employed to estimate travelers’ mode preference, but this was beyond the scope of this study.

- The simple demand-forecasting model employed in this analysis of the Boston case has several limitations. In particular, it fails to account for transportation network effects, essentially understanding each station catchment area as an abstract entity, rather than a small part of large and thoroughly interrelated system. More sophisticated network analysis might refine the model results somewhat, and provide a more accurate forecast of demand for park-and-ride capacity.

- The assumption that all park-and-ride trips replace formerly drive-alone trips, and that all commuter rail trips (under TOD conditions) replace drive-alone trips, are surely inaccurate. The park-and-ride literature presents different figures for the replacement of drive-alone trips, but these are inconsistent by study and location (Turnbull et al., 2004). Regional survey data for park-and-ride users and TOD residents could provide a more accurate picture as to the actual rate of drive-alone trip replacement.

- Borrowing an expected value for commuter rail mode share for TOD residents, and applying it to all of the case study stations, as this approach does, fails to account for local factors (especially as the 17% value employed here came from studies in California). A more thorough discrete choice approach might better account for local characteristics of the region and site.

- This approach fails to account for the congestion effect caused by increased residential densities at TODs, which might have impacts on travel behavior in nearby communities.

- The cost and legal/political challenges to realistically implementing transit-oriented development at any of these stations are not considered in this approach. These are
critical components of TOD siting and implementation, and their absence here does not reflect any sort of a diminished role for these factors. Rather, the real world considerations of TOD construction are simply far beyond the scope of this project, though simulation of these effects may be a promising topic for future research.
Chapter 5

Analysis Results for Eight Case Study Stations in the Boston Region

Low-density stations in the Boston case study include Shirley, South Weymouth, Stoughton, and Wilmington. Shirley is a mostly rural community in Central Massachusetts, whereas, on the other end of the spectrum, Stoughton represents a very typical medium-density suburban community. For each of these stations, the VMT-reduction effects available from park-and-ride greatly exceed those offered by TOD on parking lot land. The small park-and-ride facility at Shirley station is among the most cost- and space-effective of the eight case study stations (see Figure 5.4). The estimated demand for parking and actual current lot capacities at each of the eight stations are shown in Table 5.1.

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<th>Station</th>
<th>Type</th>
<th>Simulated parking capacity</th>
<th>Actual capacity</th>
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<tr>
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<td>Stoughton</td>
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<tr>
<td>Wilmington</td>
<td>Low density</td>
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<td>Urban area</td>
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<tr>
<td>W. Medford</td>
<td>Urban area</td>
<td>1272</td>
<td>36</td>
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</tbody>
</table>

Table 5.1: Simulated & Actual Parking Capacities at Case Study Stations

Shirley

Shirley station lies near the center of a rural community, on the Fitchburg Line, nearly 50 miles Northwest of downtown Boston; it is the furthest of the case study stations from the CBD (for a map of the Shirley station catchment area, including major roads and census tracts, see Figure 5.1, below). More than 47,000 people live within a 10-minute travel-time buffer of the station, in the city of Shirley and areas just beyond. At 324 persons per square mile, the population density within this catchment area is the lowest among the case stations.
Chapter 5. Analysis Results for Eight Case Study Stations in the Boston Region

Figure 5.1: Map of the Shirley station & simulated catchment area

The simulated (and some actual) data for Shirley station are provided in Tables 5.2 and ???. There are currently 64 parking spaces at the Shirley commuter rail station, and these fill to capacity daily (C.T.P.S., 2006). Parking at Shirley station is free. A one-way rail ticket from Shirley to N. Station costs $7.75. The station is served by 5 trains during a.m. peak travel hours, beginning at 5:59 a.m. and arriving at roughly 20-minute intervals thereafter. Travel time by train from Shirley station to North Station in Boston ranges from 62-79 minutes. This compares to 62 minutes by car. Driving-route distances from Shirley to downtown Boston average 54.8 miles, and home-to-station trips for residences in the Shirley catchment area average 3.5 miles.

Commuter rail represents the only frequent-service transit option for commuters in the Shirley station catchment area. Despite its distance from Boston, 13.1% of residents within the Shirley station catchment area regularly commute to downtown Boston or Cambridge (CTPP, 2000), though this is the lowest CBD-commuter percentage among the case stations.

As Table 5.2 shows, simulated demand for station parking here exceeds current station parking by 39 spaces. Actual demand for parking at this station also exceeds existing supply: the lot fills to capacity every day, typically by 7:00 am (C.T.P.S., 2006). The cost of parking capacity expansion at Shirley is likely less than at other case study stations, due to Shirley’s distance from Boston. 103 spaces the parking lot would still be modest in size, with a relatively low opportunity cost (understood as the forgone annual rents the land might yield if developed for other uses). Additionally, the opportunity cost value generated by the simulation is probably higher than the actual value, as it is unlikely that the market in Shirley could immediately absorb the new development at the station site.

The TOD scenario assumes that the existing 64-space parking lot is converted to medium-density TOD (12.5 persons/acre, 8000 persons/sq. mile). This small development could house 5 people. Assuming a 17% commuter rail mode share for work trips, this TOD
will reduce locally-generated commute VMT by 48 vehicle-miles per day, assuming that TOD development replaces residential development that would have occurred elsewhere within the catchment area. Conversion of the parking lot to TOD, would force many current park-and-ride users to commute by car, which would result in a net increase in daily VMT of 6038/day.

**South Weymouth**

South Weymouth station abuts the now-closed South Weymouth Naval Air Station, on the Old Colony Rail Line, southeast of Boston. South Weymouth station currently serves a number of mostly low-density communities, west and south of the former Naval Air Base. The station has a 530-space parking lot, and regularly fills to capacity (C.T.P.S., 2006). A map of the South Weymouth catchment area (Figure 5.2) is provided below.

Simulation data for South Weymouth station is summarized in Tables 5.2 and ???. The South Weymouth Naval Air Station was established in 1942, and served as a functioning military aviation facility until it was decommissioned in 1996. For much of its tenure, the base housed thousands of active-duty Navy, Marines, and Coast Guard, and hosted air shows that sometimes drew more than 100,000 on-lookers. In 2005, the Base property was purchased by a group of development interests, and plans are underway to develop several thousand units of housing, as well as commercial and industrial (mainly biotech) facilities on the site. The developers are actively portraying the project as transit-oriented development and Smart Growth.

Despite significant capacity, the lot at South Weymouth station fills everyday before the last a.m. train has departed (C.T.P.S., 2006). The lower-than-actual demand generated by the simulation might be caused by an over-restrictive travel-time (home-to-station) buffer for catchment area estimation (10 minutes), or may be because a larger-than-expected share
of commuters from denser communities to the North travel to South Weymouth station rather than to Braintree or Weymouth Landing stations. The strong actual demand for station parking is likely the result of the strong share of area residents commuting to the CBD, 24.8%. This is a significantly greater share than for any other comparably-dense or -distant communities in the Boston case study.

Converting the existing 530-space parking lot to TOD would provide housing for 42 people, and would result in a daily VMT reduction (compared to VMT assuming comparable development, elsewhere in the catchment area) of 116 vehicle-miles per day, and a net increase in locally-generated VMT of 15,336/day.

Providing parking at South Weymouth station appears currently to be a very effective means of reducing work trip VMT from South Shore communities. It would be interesting to observe the coexistence of a busy parking facility and a large, fairly dense TOD at the same station. Whereas some urban areas have tended to choose either parking or dense development as the dominant transit station land-use, the MBTA is, for the most part, doing its best to have things both ways. While parking lots certainly generate a number of negative externalities that might be felt by nearby residents, it does not appear impossible that these two uses could occupy adjacent sites with little negative impacts on one another.

**Stoughton**

Stoughton station serves the low-density suburban community of Stoughton, the end of one branch of the Providence/Stoughton Line. The community is about 20 miles South of Boston, in the heavily-suburban zone between radial Interstates 95 and 495. Relatively high shares of catchment area residents commute regularly to the CBD (18.5%), and travel to work by commuter rail (6.1%) (CTPP, 2000, Census, 2000). The station includes parking capacity for 544 vehicles, and has an average utilization rate of 99% (see Table 5.2) (C.T.P.S., 2006).
The simulation's under-prediction of parking demand at Stoughton station is likely not caused by under-estimation of the station catchment area, which, owing to the abundance of highways and arterial roads near the station, is rather large. The relatively high commuter rail trip share for catchment area residents is orders of magnitude greater than that assumed by the simulation. Though data is not available for the share of park-and-ride trips, the high commuter rail mode share and actual demand well above the simulated value suggest that park-and-ride is a popular means of transportation to work for residents in this area. However, such a conclusion is not intuitive from the transit service characteristics. The high cost and travel time ratios imply that transit should be disadvantaged relative to driving, as a means of transportation to work. Local roadway congestion not captured by the simulation could explain this.

Park-and-ride at Stoughton provides a significant reduction in locally-generated VMT: more than 12,000 vehicle-miles per day, or .013% of total daily regional VMT, at a cost of $.58 per travel mile reduced. Even at a relatively effective (in terms of utilization and compared to TOD conditions) station like Stoughton, the opportunity cost of providing a large parcel of station-area land for commuter parking is significant. This land area, currently a parking lot, deserves consideration as a potential development site, and a genuine evaluation of what benefits it provides now, vs. those it might provide, and how these should be evaluated.

The TOD simulation shows that conversion of the 544-space parking lot to TOD could provide housing for 43 people, and a daily VMT reduction of 96 vehicle-miles per day. This would result in a net increase of 18,696 VMT/day, generated by former park-and-ride users, now forced to commute by car.

**Wilmington**

Wilmington CRR station is served by the Lowell Line, and provides commuter rail service to the community of Wilmington and the surrounding low-density residential areas, roughly 15 miles North of Boston, and about equidistant between Boston and Lowell. Wilmington lies in the largely-suburban zone between the dense inner-Metro-North suburbs, to the south, and the historic urban centers of Lowell and Lawrence to the north. The station is located on Rte. 129, a major arterial, near where 129 joins Rtes. 62 and 38, also suburban arterials. The catchment area for Wilmington station is relatively large, owing its excellent roadway accessibility to residential communities to the northeast, northwest and south (see Figure 5.4).

Simulation data for Wilmington station are presented in Tables 5.2 and ??. The station adjoins a parking lot with capacity for 184 vehicles. The utilization rate for this lot is 100%; the lot was observed to reach capacity, on average, at 7:33 a.m. — more than an hour before the departure of the last a.m. train, and the earliest fill-time for any station on the Lowell Line (C.T.P.S., 2006). Simulated demand for parking at Wilmington station is 339 spaces. Meeting this demand would involve an 85% increase over existing station parking capacity. Such an increase appears warranted, based on the current utilization rate and fill-time. The yearly opportunity cost of providing the current amount of station parking capacity is roughly $955,834. Expanding parking capacity to meet simulated demand at Wilmington station would increase this amount 85%, to $1.76 million. This cost would
lead to further reduction of VMT from 4828 vehicle-miles per day (the amount mitigated by current park-and-ride capacity) to 8894 miles/day. As with Stoughton, station parking at Wilmington is effective in achieving reductions in locally-generated commute VMT, but does so at a significant cost. Converting the parking lot to TOD would generate revenue for the MBTA, but would result in 4788 new daily VMT.

5.1 Suburban-center Stations

Suburban-center stations in the Boston region case study include Norwood and West Natick, both of which are generally medium-density upper-middle-class communities. Simulated travel effects for these stations (see Table 5.4) show that park-and-ride provides VMT reduction benefits very efficiently in both communities.

Norwood Central

A map of Norwood Central station and catchment area is provided below (see Figure 5.5). Norwood is a suburban community approximately 20 miles Southwest of Boston. The town is just West of Interstate 95, and Rte. 1, a suburban highway, that runs adjacent to the east edge of town. These highways provide Norwood with excellent auto access to Boston and the larger region. The community is served by three commuter rail stations (Norwood Central, Norwood Depot, and Windsor Gardens stations), all on the Forge Park/495 Line. 23.2% of Norwood residents commute to the CBD, and 10% travel to work via commuter rail. The accessibility provided by multiple local stations, as well as the high share of CBD commuters likely support this commuter rail use. Norwood central station includes a parking lot with capacity for 764 vehicles, with a utilization rate of 78% (C.T.P.S., 2006).
Norwood depot station, less than 1 mile North (inbound) of Norwood Central, includes capacity for 215 vehicles, and shows 48% utilization; Windsor Gardens station does not include a parking facility (C.T.P.S., 2006).

Simulation results for Norwood Central station are presented in Tables 5.2 and ???. The demand simulation greatly underestimated demand for station parking at Norwood station, likely in part because of the stronger-than-average local share of commuter rail work trips. Norwood’s 10% commuter rail mode share is the highest among case study station communities; West Natick (7.7%) and Stoughton (6.4%), communities have high commuter rail mode shares and fall well short of Norwood’s share of work trips by commuter rail. Even so, the utilization data suggests that Norwood is currently over-supplied with station area parking. The 78% utilization value at Norwood Central station is acceptable, given that 85-90% utilization is considered ideal (more than this indicates inadequate supply, and operators begin to fear the effects of turning would-be riders away), but the parking lot at Norwood Depot station does not reach even half capacity on a typical day. The MBTA should consider selling this lot or partnering with a developer to convert it to another use. Park-and-ride users displaced by this action could be absorbed by the available capacity at Norwood Central, with insignificant home-to-station trip distance increase.

![Figure 5.5: Map of Norwood Central station & simulated catchment area](image)

West Natick

West Natick station serves parts of Natick and Framingham, the former a wealthy residential community and the latter a middle-class suburban center, roughly 20 miles west of Boston. West Natick station is flanked by Framingham and Natick CRR stations to the west and east, each approximately 2 miles away (see Figure 5.6). The density of the surrounding communities and scarcity of highways or arterial roadways cause the
Chapter 5. Analysis Results for Eight Case Study Stations in the Boston Region

Simulation to generate a relatively small catchment area for the station, from which the stations to the East and West also draw much of their ridership. West Natick station supports parking for 194 vehicles, and was observed to reach capacity at 6:40 a.m., more than 2 hours before the last a.m. train departs (C.T.P.S., 2006).

Simulation results are presented in Tables 5.2 and ???. Likely owing to the strong share of local work-trips by commuter rail (7.7%), the simulation again under-predicted demand for parking at West Natick station, though only falling 35 spaces short of existing capacity. Judging by the time at which the lot was observed to have reached capacity (the earliest among the 8 case stations), it is reasonable to assume that actual demand well-exceeds present capacity.

Figure 5.6: Map of West Natick station & catchment area

Simulated VMT reductions from park-and-ride at West Natick station is among the more efficient among stations in the case study, at $.35 per mile reduced. The low ratio of home-to-station trip distance to station-to-CBD trip distance, demonstration of demand well in excess of estimated or currently-supplied parking capacity, and the high share of work-trips by commuter rail all imply that station parking is capable of yielding greater reductions in locally-generated VMT, if supply can be expanded.

The VMT impact of TOD relative to assumed non-TOD conditions at West Natick station is minimal (50 vehicle-miles per day reduced), and the net effect of converting the 194-space parking lot to development would be a daily increase of 7,720 VMT/day.

5.2 Urban Area Stations

Urban area stations in the case study include Lynn and West Medford Stations. At both urban-area stations, Lynn and West Medford, actual demand for station parking is quite low (C.T.P.S., 2006). The relatively higher value of land in these communities drives up
5.2. Urban Area Stations

the opportunity cost of providing commuter parking. This combination of poor demand and relatively high opportunity cost suggest that parking facilities at urban-area stations will provide VMT reduction benefits relatively less efficiently than at lower-density, more distant stations.

Lynn

Lynn is a fairly dense working class community on Massachusetts Bay, 10 miles Northeast of Boston. The commuter rail station lies near the center of the city, and is served by the Newburyport/Rockport Line. Relative to low-density and suburban-center stations, Lynn has a fairly standard transit mode share for work trips, but a very low value for commuter rail trips (more on this point below). Lynn is the densest community in the Boston case study, with an average catchment area population density of 11,015 persons per square mile. Though relatively near to downtown Boston, the share of Lynn residents commuting to the CBD is not significantly higher than that of several more distant stations. Figure 5.7 provides a map of the Lynn station and catchment area, and Tables 5.2 and ?? detail the simulation results.

Lynn station includes a 939-space parking lot that, on average, fills to only 33% of capacity. The simulation estimated demand for 1099 spaces at Lynn station, well above even current capacity, and nearly 3-times actual demonstrated demand. This discrepancy is puzzling, though it is interesting that this study’s methodology and the MBTA’s own methods for determining demand for parking came to such similar incorrect results. One explanation for the difference between the simulated and actual levels of parking demand may have to do with Lynn’s relative proximity to Boston, and to bus and subway service, in particular. Most transit users, including those bound for the CBD, are likely taking the bus, or driving to subway stations in Revere (Wonderland station has capacity for 2477 vehicles) 4.5 few miles South. Driving this extra distance saves the commuter nearly the cost of a commuter rail ticket, as parking at Wonderland is only $1 more expensive than at Lynn. More importantly, driving directly to the subway saves most rail commuters the hassle of transferring from commuter rail to the subway, and reduces their overall travel time. This transfer penalty is relatively greater because of Lynn’s proximity to the CBD; a five-minute wait at a transfer station will likely feel more costly to a traveler, the greater the share it represents of their overall trip time (or their potential trip time by car).

Conversion of the 939-space parking lot at Lynn station to TOD could provide housing for 148 people, and a VMT reduction (relative to current development patterns) of 258 vehicle-miles/day. This would result in a net increase in VMT of 4832/day, assuming the 339 daily current park-and-ride users all choose to commute by car. This increase would be offset by the rent-generating potential of that land, approximately $6.47 million per year. Currently, the large, under-utilized lot at Lynn station achieves a daily VMT reduction of 5090/day, or $4.89/mile.³ Clearly this does not represent a cost-effective use of station-area land.
Chapter 5. Analysis Results for Eight Case Study Stations in the Boston Region

Figure 5.7: Map of Lynn station & catchment area

West Medford

West Medford station, on the Lowell Line, serves areas of the inner-suburban community of Medford, 6.5 miles Northwest of downtown Boston (see Figure 5.8). The estimated catchment area population is 66,194, with an average population density of 10,543 persons per square mile. Because of its proximity to downtown Boston, and especially to rail transit-served areas of Cambridge and Somerville, residents of the West Medford catchment area have by far the greatest share of CBD-bound work trips (47.1% — understanding the CBD, as opposed to downtown Boston, as all areas directly accessible by MBTA subway service). CTPS lists West Medford station as including 77 parking spaces, but 41 of these are on-street spaces, with residential permit requirements during non-daytime hours. A 36-space lot adjoins the station property, and fills to capacity daily (C.T.P.S., 2006).

Tables 5.2 and ?? shows the simulation results for West Medford station. As with Lynn, residents of the West Medford station catchment area have a high transit mode share for work trips (18.1%), but a very low share of these go by commuter rail (.1%). Instead, many residents likely take advantage of local bus service, or drive to the Alewife subway station (capacity 2,486) less than 3 miles south. Also like Lynn, the simulation again over-predicts demand for station parking at West Medford, estimating demand at 1272 spaces. This over-prediction is caused by the extremely high share of CBD commuters, which the model understands as potential commuter rail park-and-riders. However, because West Medford station is near to a large subway park-and-ride, and also only about three miles from two of the areas included in the simulation as CBD destinations (Alewife and Porter Squares were included because of their transit accessibility), many of these commuters are not likely to use commuter rail park-and-ride.

As was the case with Lynn, where the simulation over-estimated demand for station parking, the results for West Medford strongly imply that increasing station-area parking
supply would be a costly and inefficient means of reducing commute VMT. Unlike at Lynn, however, at West Medford station the MBTA does not own a large surface parking lot (the small 36-space lot adjacent to the station is privately held) so questions of whether TOD would be more appropriate are not as relevant. A net increase in commute VMT would result from conversion of the parking lot to TOD, but this increase would be very minimal: only 304 vehicle-miles per day. What is most evident from the simulation results at West Medford station is that parking expansion is not the best use of station area land. TOD could take advantage of bus service and other nearby transit options, and providing additional benefits for other local transit users.

Figure 5.8: Map of West Medford station catchment area

5.3 Summary

At several of the low-density and suburban-center stations, park-and-ride lots appear to offer cost-effective means of increasing residents’ access to transit and reducing commute-generated VMT. A few of these stations – Stoughton, possibly Norwood and South Weymouth – provide a worthwhile service that, if it is truly worthwhile, deserves to be expanded. Other stations, including Lynn, West Medford and West Natick, show poor results, and the decision to provide commuter parking at these stations deserves to be questioned. Table 5.4 presents a summary of simulated and actual effectiveness of park-and-ride at the 8 case study stations. A number of trends with relevance for transit agency officials, the development community, and policymakers appear in the simulation results:

- Park-and-ride is far more effective at reducing commute VMT, on a per square foot basis, than transit-oriented development. Even at Lynn station, with the largest parking facility in the Boston case study (and one of the largest on the MBTA
### Park-and-Ride Results

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<thead>
<tr>
<th>Station type</th>
<th>Shirley</th>
<th>S. Weymouth</th>
<th>Stoughton</th>
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### Park-and-Ride Results

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<th>Norwood</th>
<th>W. Natick</th>
<th>Lynn</th>
<th>W. Medford</th>
</tr>
</thead>
<tbody>
<tr>
<td>Miles from CBD</td>
<td>Suburban center</td>
<td>Suburban center</td>
<td>Urban area</td>
<td>Urban area</td>
</tr>
<tr>
<td>Station-trip distance (in miles)</td>
<td>22.6</td>
<td>22.4</td>
<td>10</td>
<td>6.6</td>
</tr>
<tr>
<td>% Commuting to CBD</td>
<td>23.2</td>
<td>16.3</td>
<td>19.9</td>
<td>47.1</td>
</tr>
<tr>
<td>Parking capacity currently</td>
<td>764</td>
<td>194</td>
<td>939</td>
<td>36</td>
</tr>
<tr>
<td>Estimated demand for parking</td>
<td>276</td>
<td>159</td>
<td>1099</td>
<td>1272</td>
</tr>
<tr>
<td>Acres used for parking (estimated)</td>
<td>1.74</td>
<td>1.00</td>
<td>6.94</td>
<td>8.03</td>
</tr>
<tr>
<td>Net VMT effect of P&amp;R</td>
<td>11,040</td>
<td>6,360</td>
<td>16,485</td>
<td>10,939</td>
</tr>
<tr>
<td>Annualized value of land</td>
<td>$1,242,483</td>
<td>$715,778</td>
<td>$6,467,615</td>
<td>$7,485,720</td>
</tr>
</tbody>
</table>

Table 5.2: Summary of estimated park-and-ride effects on commute-generated VMT

### TOD Results

<table>
<thead>
<tr>
<th>Shirley</th>
<th>S. Weymouth</th>
<th>Stoughton</th>
<th>Wilmington</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projected TOD density (dwelling units per acre)</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>Initial drive-alone mode share (work trips)</td>
<td>84.7%</td>
<td>80.8%</td>
<td>78.6%</td>
</tr>
<tr>
<td>TOD mode shift effect</td>
<td>14.9%</td>
<td>15%</td>
<td>10.6%</td>
</tr>
<tr>
<td>Commute VMT w/o TOD</td>
<td>630</td>
<td>1566</td>
<td>2384</td>
</tr>
<tr>
<td>Commute VMT w/TOD</td>
<td>520</td>
<td>1274</td>
<td>2064</td>
</tr>
<tr>
<td>VMT reduced by TOD</td>
<td>110</td>
<td>582</td>
<td>320</td>
</tr>
<tr>
<td>Density for comparable effect (d.u./acre)</td>
<td>658</td>
<td>695</td>
<td>935</td>
</tr>
</tbody>
</table>

Table 5.3: Summary of estimated TOD effects on commute-generated VMT
5.3. Summary

and with the lowest current utilization, park-and-ride reduces more than 5,000 vehicle-miles per day in addition to the reduction achieved by a simulated TOD on that site.

- The opportunity cost of providing station parking is very high. The median annual rents forgone by the use of station-area land for parking is $1.8 million. There are commuter parking facilities on publicly owned land at 107 commuter rail stations in the Boston region. These sites represent a major potential annual windfall, if developed for other uses. The median cost of parking at these facilities is $2/day, which falls somewhat short of the total cost to develop and operate the facilities (Ron Morgan, 2008, personal communication). The MBTA currently faces an uncertain financial future, and a debt burden in the billions of dollars, suggesting that conversion of MBTA-owned parking lots to other rent-generating uses deserves strong consideration at any poorly-functioning facility.

- Demand for commuter rail park-and-ride at case study stations is associated with three factors: catchment area population size, share of catchment area residents commuting to the CBD, and the station’s distance from the CBD. The first factor is intuitively obvious, and the second (share of CBD commuters) is unsurprising. But a high share of CBD commuting among catchment area residents, alone, does not necessarily indicate that demand for station parking will be high. West Medford station demonstrated the greatest share of CBD commuters, and extremely low actual demand for parking (the 36-space lot fills daily, but 41 on-street spaces adjacent the station are typically not all filled (C.T.P.S., 2006)) – actual demonstrated demand here is 5% of the simulated value. Stations further from the CBD, with relatively strong shares of CBD-bound commutes, such as West Natick and South Weymouth, show very strong actual demand for parking; each of these stations fills to capacity well before the final a.m. train.

- The overall potential of station parking to reduce VMT is less dependent on parking capacity than one might expect. In general, stations with more parking capacity demonstrated greater VMT reductions than stations with smaller lots. However, several stations in the Boston case illustrate an opposite trend; Norwood Central station, for instance, provides 80% as much VMT reduction as West Medford, with less than 20% the capacity. Other factors, in particular facility utilization (itself influenced by many different factors, a number of which – as evidenced by West Medford and Lynn stations – are not captured by this simulation) and trip distance ratio, play important roles in the park-and-ride’s effectiveness at reducing VMT. Park-and-ride cost-effectiveness, trip distance ratio, and CBD-bound commute share are presented in Table 5.5.

- A station’s distance from downtown Boston, and in particular the ratio of home-to-station length to station-to-downtown length (a proxy for the full commute distance), are as important as capacity in determining the VMT effect of park-and-ride. As capacity is directly linked to the opportunity cost of providing parking, the trip distance ratio is the most critical factor in determining the per-space
Table 5.4: Lot sizes, daily VMT reductions & cost-effectiveness

<table>
<thead>
<tr>
<th>Station</th>
<th>VMT Reduction (/day)</th>
<th>Opportunity Cost</th>
<th>Cost per VMT Reduced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shirley</td>
<td>9796</td>
<td>$428,104</td>
<td>$.17</td>
</tr>
<tr>
<td>S. Weymouth</td>
<td>7726</td>
<td>$1273258</td>
<td>$.63</td>
</tr>
<tr>
<td>Stoughton</td>
<td>12022</td>
<td>$1,808,212</td>
<td>$.58</td>
</tr>
<tr>
<td>Wilmington</td>
<td>8894</td>
<td>$1,761,253</td>
<td>$.76</td>
</tr>
<tr>
<td>Norwood</td>
<td>11040</td>
<td>$1,242,748</td>
<td>$.43</td>
</tr>
<tr>
<td>W. Natick</td>
<td>6368</td>
<td>$715,391</td>
<td>$.35</td>
</tr>
<tr>
<td>Lynn</td>
<td>16502</td>
<td>$6,470,213</td>
<td>$1.51</td>
</tr>
<tr>
<td>W. Medford</td>
<td>10922</td>
<td>$7,485,720</td>
<td>$2.64</td>
</tr>
</tbody>
</table>

Table 5.5: Station cost-effectiveness, trip-distance ratio, distance from CBD and share of CBD-bound commutes

<table>
<thead>
<tr>
<th>Station</th>
<th>Efficiency $/VMT reduced</th>
<th>Trip distance ratio</th>
<th>Distance to CBD</th>
<th>Share of CBD commutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shirley</td>
<td>$.16</td>
<td>15.5</td>
<td>54.4</td>
<td>13.1%</td>
</tr>
<tr>
<td>S. Weymouth</td>
<td>$.63</td>
<td>9.8</td>
<td>17.6</td>
<td>24.8%</td>
</tr>
<tr>
<td>Stoughton</td>
<td>$.58</td>
<td>7.4</td>
<td>20.0</td>
<td>18.5%</td>
</tr>
<tr>
<td>Wilmington</td>
<td>$.76</td>
<td>4.3</td>
<td>17.1</td>
<td>17.2%</td>
</tr>
<tr>
<td>Norwood</td>
<td>$.55</td>
<td>8.7</td>
<td>22.4</td>
<td>23.2%</td>
</tr>
<tr>
<td>W. Natick</td>
<td>$.35</td>
<td>9.3</td>
<td>22.6</td>
<td>16.3%</td>
</tr>
<tr>
<td>Lynn</td>
<td>$4.57</td>
<td>4</td>
<td>10.0</td>
<td>19.9%</td>
</tr>
<tr>
<td>W. Medford</td>
<td>$2.64</td>
<td>2.9</td>
<td>6.6</td>
<td>47.1%</td>
</tr>
</tbody>
</table>


5.3. Summary

(or per-dollar) effectiveness of station parking. This is why Shirley, which achieves a modest simulated VMT reduction of 9,796 vehicle-miles per day, does so at an astonishingly efficient $.17 per vehicle-mile reduced. The trip distance ratio for Shirley’s catchment area is 15.54, also by far the highest for any station in the case study.

- Station parking is relatively more effective, both in terms of cost, and relative to a TOD alternative, in low- and medium-density areas. This effectiveness is apparent both in the simulated results, and in actual utilization data. This result bears out the assertion, made by several park-and-ride observers, that, in general, park-and-ride service is more attractive to users and more effective at reducing VMT at terminal stations, or when the transit trip distance significantly exceeds the auto trip distance (Noel, 1988; Arnott, 2006; Turnbull et al., 2004; Meek, 2008). With TOD gaining increasing acceptance as a good investment opportunity and as a means of reducing VMT, developers, transit agencies and municipalities will continue to seek out opportunities to convert current uses to TOD. In this context, the conclusion that station parking is relatively more cost- and space-effective the further it is from the CBD, takes on added relevance.

<table>
<thead>
<tr>
<th>Station</th>
<th>Type</th>
<th>VMT reduction from P&amp;R Actual (/day)</th>
<th>TOD density required (d.u./acre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shirley</td>
<td>Low density</td>
<td>6,087</td>
<td>658</td>
</tr>
<tr>
<td>S. Weymouth</td>
<td>Low density</td>
<td>16,713</td>
<td>695</td>
</tr>
<tr>
<td>Stoughton</td>
<td>Low density</td>
<td>18,793</td>
<td>935</td>
</tr>
<tr>
<td>Wilmington</td>
<td>Low density</td>
<td>4,827</td>
<td>571</td>
</tr>
<tr>
<td>Norwood</td>
<td>Suburban center</td>
<td>30,560</td>
<td>1,454</td>
</tr>
<tr>
<td>W. Natick</td>
<td>Suburban center</td>
<td>7,770</td>
<td>1,263</td>
</tr>
<tr>
<td>Lynn</td>
<td>Urban area</td>
<td>4,653</td>
<td>175</td>
</tr>
<tr>
<td>W. Medford</td>
<td>Urban area</td>
<td>309</td>
<td>469</td>
</tr>
</tbody>
</table>

Table 5.6: TOD densities required to produce VMT effect comparable to park-and-ride

- Table 5.6 shows the VMT reduction that this approach estimates is provided by the currently existing (non-simulated) parking capacity at the eight case stations, and the dwelling unit density (assuming TOD is built only on the land area currently occupied by parking) that would be required for TOD to generate an equivalent reduction. The results indicated that, for all cases, the required TOD density is unreasonably high. The relatively lower density requirement at Lynn station, however, suggests that a dense TOD (say 50 d.u./acre) could provide a significant proportion of the park-and-ride's effect. Recognizing that these values fail to account for the non-commute trip effects of TOD, which are likely to offset some further amount of VMT, these results indicate that redeveloping the parking lot at Lynn to dense TOD might entail little loss of VMT-reduction benefits. Such redevelopment would also provide a number of new benefits, for the local community (housing, amenities, etc.) and the MBTA (a new revenue stream).
Chapter 6
Conclusions & Implications for Policy

Transit stations create new value in nearby land. Accessibility to high quality transit service has been demonstrated to generate a price premium (Cervero, 2001, 2004), but as traffic congestion, deteriorating urban air quality and global climate change impose increasing costs on our cities, transit stations have begun to convey another extra-economic value to this land. Transit stations present sites of opportunity, places that offer the potential to realize a number of diverse and sometimes competing goals: congestion reduction, fair & equitable transportation options, healthier communities, and potentially lower transport-sector GHG emissions, to name a few. The uses that are placed on station-area land embody these goals (or they should) and the ways in which we hope to realize them.

Park-and-ride facilities serve the goal of extending access to high-quality transit service to areas and residents beyond the immediate station-area. In the Boston region these facilities extend to residents in communities throughout the region the option of taking transit — providing them cost and comfort benefits, and reducing their contribution to roadway congestion, pollution and climate change. Park-and-ride does these things successfully in many places, as is demonstrated by the large share of station parking facilities that fill to capacity daily, both in the Boston region and in many other U.S. metropolitan areas. And, as recent opinion pieces and letters to the editor in local newspapers show (Long, 2008), commuter demand for parking at transit stations is rising.

But using land adjacent to transit stations as a storage space for automobiles seems perverse to many planners and researchers (Bernick and Cervero, 1997; Cervero, 2001; Garrick, 2007). Station-area land has value both in terms of the rents that it could command and in its value for realizing other goals for our urban areas; putting that land to no use other than parking during work-hours fails to capture much of this value, and builds in a dependence on the automobile, while the larger policy aim is to escape from auto-dependence. Furthermore, the costs and benefits of park-and-ride generally privilege regional interests over those of the local community: the benefits (expanded access to transit, more livable downtowns) largely accrue elsewhere, but the costs (traffic, pollution, crime) are tied to the station site. Park-and-ride may offer certain travel and air-quality benefits, but it has a host of associated costs, as well.

Transit-oriented development appears to offer an excellent alternative use, one that capitalizes better on the economic value of the land and provides a number of other benefits such as increasing walking and transit use, and providing comfortable, livable
neighborhoods. Its benefits accrue locally, though reduced traffic and vehicle emissions benefit all urban residents. In short, park-and-ride and transit-oriented development pose a classic tradeoff, each offering benefits at certain costs. The question before transit agency officials, city governments and the public is which land use to pursue where?

6.0.1 The Components of Decision-Making: Regional Goals & Place-Based Effectiveness

This study began with the hypothesis that the tradeoff between park-and-ride and transit-oriented development is context-dependent, governed by a range of regional and local factors. From there this study developed and applied a basic comparative methodology to the travel benefits and associated costs of park-and-ride and transit-oriented development, in order to land-use decision-making at transit stations.

Some patterns are visible in both the simulated and actual data (see §5.3), and these show mostly what we might expect: park-and-ride does provide a significant reduction in daily commute-generated VMT, far more than is achievable by conversion of parking facilities to transit-oriented development, as it is defined in this research. However station parking is expensive to provide, and serves only a very limited set of goals. Replacing parking lots with TOD could generate a sizable windfall in rents for the MBTA, and provide additional housing, amenities and quality-of-life measures for local residents. However this conversion would, in each of the cases analyzed, result in a net increase in daily VMT, and the associated increases in congestion, road maintenance costs and vehicle emissions. However in the case of Lynn station, the largest and worst-performing facility in the study, the simulation shows that high-density TOD could provide a significant share of the VMT reduction currently provided by park-and-ride (see Table 5.6). In these cost/benefit tradeoffs, the data bears out the initial assumption that neither park-and-ride nor TOD represent a one-size-fits-all solution for land-use planning at transit stations. Park-and-ride generally provides a greater VMT reduction benefit than TOD, but to a varying degree, and at a much higher cost.

The goals and policy aims of political leaders, the development community, and residents of an urban area will also have a determining effect on the relative quality of land-use options. The threshold for cost per daily vehicle-mile reduced may be much higher in a city struggling to deal with traffic congestion, than in another community with a great need for additional housing, or with strong demonstrated demand for walkable neighborhoods and pedestrian accessibility.

Bearing these two things in mind — that the choice between park-and-ride and TOD represents a set of tradeoffs, rather than a simple loss or gain, and that the goals of a community are as important in determining what the best use will be for station-area land — the analysis suggests a number of implications for station-area land-use planning and regional transportation policy.
6.1 Factors Governing Park-and-Ride Performance

In any choice involving tradeoffs between sets of different costs and benefits, an important aspect of the choice of one land-use or another should be the efficiency with which each use will operate, or the ratio of benefits delivered to associated costs. For park-and-ride this comes down to the number of daily vehicle-miles reduced per parking space, square foot or rent dollar foregone. Some developers and planners, those that find parking facilities antithetical to the aims and profit margins of TOD, might suggest that efficiency per station is also relevant, as any amount of park-and-ride would necessarily preclude other desirable uses in that station area. In this regard the results (see Table 5.2) show two things: 1. that demand for station parking is associated with distance from the CBD and the share of local residents commuting to the CBD; and 2. that efficiency varies in large part according to the ratio of miles traveled to access transit to the foregone commute distance.

As §5.3 shows, the ratio of miles traveled (by car) to access commuter rail service to the commute-distance foregone (now via commuter rail), does much to determine the efficiency of a park-and-ride facility (see also Tables 5.2 and ??). The trip distance ratio represents the rate at which transit miles replace driving miles for park-and-ride users. If performance is essentially the amount of benefits delivered per cost X, then for park-and-ride, the trip distance ratio is fully half the performance equation. The difference in daily VMT reduced per space at Shirley station and at Wilmington station is demonstrative of this: both stations experience strong demand for parking (both lots typically fill more than an hour before the final a.m. train departs), but though Wilmington has capacity for more than three times as many users (339 spaces to 103), park-and-ride at Shirley station outperforms Wilmington station by more than 900 vehicle-miles per day. Each parking space at Shirley station accounts for 85.4 vehicle-miles reduced each day, compared to 26.2 vehicle-miles per space at Wilmington. This is because each mile traveled to access transit at Shirley is “paid back” with 15.4 miles foregone, versus a ratio of 4.3 station-trip to work-trip miles at Wilmington. This disparity will be in greater evidence at stations with lower trip distance ratios and utilization rates than Wilmington station, the case for both West Medford and Lynn stations.

6.2 Policy Implications

Insofar as transit station-area land-use decisions are governed by performance, rather than by a community’s or region’s planning and policy goals, efficiency (the amount of benefit delivered per cost X) should be the criteria by which the option to provide station parking is judged. Park-and-ride performs admirably at a number of stations in the case study, including West Natick, and Shirley, and given rising traffic congestion and growing concern over vehicle emissions, the choice to provide parking on station-area land at these stations appears more than reasonable. These parking lots provide a significant VMT-reduction benefit, as well as user-benefits to thousands of commuters, and parking-displacement from downtown Boston, and do so at a minimum cost in land area and foregone rents.

But performance at other case stations ranges from questionable (e.g. Wilmington, S. Weymouth) to downright terrible (Lynn). There are few imaginable cases in which a cost of
$4.57 for each vehicle-mile reduced (the performance of the existing park-and-ride facility at Lynn) could be worthwhile to a transit-agency, a town or a public. The wide variability of parking facility efficiencies (per dollar, space, or square foot) among the eight case study stations is surprising, and suggests that, even within a single transit agency or region, park-and-ride may represent several very different realities and consequences.

Urban areas do not need inefficient, poorly-functioning park-and-ride. Supporters of TOD have made this much clear. The value invested in land near transit stations can be captured and put toward many different goals (and a number of the same goals) as could be provided by commuter parking. Transit agencies or cities that own and operate failing park-and-ride facilities should ought to look hard at the possibilities and other potential uses for these sites. Where to draw the line that separates functioning, worthy facilities from inefficient, future development-sites is not something this study can (or perhaps even should) point to. This must be decided by the goals and plans particular to a transit agency, community or region. There seem to be examples of parking facilities that should be widely-acceptable, as well as others, like Lynn, that should be unanimously unacceptable. The fitness of those instances in-between — facilities whose performance is neither exceptional nor abominable — must be judged according to the criteria established by local issues and plans.

6.2.1 Policy Proposal: Graduated Replacement & Targeted Redevelopment

The MBTA currently accepts proposals from developers hoping to put TOD in place of station parking. The agency’s policy is to deny any proposal that results in a net decrease in available commuter parking. This has meant that, unlike in certain other urban areas, TOD development in the Boston region has not resulted in any decrease in park-and-ride capacity. In fact much of the region’s TOD construction has coincided with the period of greatest expansion in park-and-ride capacity. The 100% parking replacement policy has also restricted construction of TOD to only the most profitable locations, as financing the cost of replacing parking capacity in a structured garage has, at a number of stations, proved too great a burden to any developer’s budget.

The current policy of 100% replacement does not distinguish highly-performing stations from poor performers. Instead, targeted capacity expansion and conversion to TOD at the best- and worst-performing facilities, could generate new benefits beyond those provided by the current land-use system, at little or no cost in increased regional VMT. A graduated parking replacement rate, based on a facility’s per dollar efficiency, would encourage the redevelopment of less efficient facilities, while ensuring that only exceptional projects could be proposed for more efficient facilities. Redevelopment of the worst-performing parking lots to TOD would generate a significant new revenue stream for the MBTA which might be used to finance transit service expansion or for targeted parking capacity expansion at other stations. Likewise, the new transit-oriented communities that would result will provide numerous non-travel benefits to their local areas and residents (Bernick and Cervero, 1997; Cervero, 2001, 2004). Additionally, by demonstrating a commitment to partner with developers to build these roughly 30 TODs within the region,
6.3. Beyond the Boston Case

the MBTA and city governments will provide a strong signal that may help to drive the market for further transit-oriented development in the Boston region. This could help to set off the kind of development sea-change that is necessary if land-use is to have any more than a marginal effect on travel behavior region-wide.

Another option, particularly for the worst-functioning facilities where only a very small share of capacity should be replaced, would be to allow developers to provide on-site transportation demand management (TDM) measures, in place of parking replacement. Such measures could include a car-share program for residents, subsidized transit passes or other means of reducing the residents’ needs to own and drive automobiles. TDM measures included in this way could increase the mode shift effect among TOD residents, and providing a greater VMT reduction per resident.

6.2.2 Limitations and Future Research

The approach employed in the case study analysis of Boston region commuter rail stations has a number of limitations (also see §4.1.2), among them a lack of consideration for innovative community designs that accommodate dense development and commuter parking, or alternative station access programs. Indeed, such designs and programs may represent the most complete capture of the extra-economic value of transit-station land, by extending a great variety of benefits across communities, and allowing residents throughout a metro region to take advantage of transit services. Future research into the success of innovative community designs, and their impacts on travel behavior, could be of great use in helping to advance the thinking around station land-use decision-making.

This study does not intend to further the perception of any kind of inherent opposition between TOD and commuter parking. This perception may begin to erode, as innovative planners and developers explore the possibilities of community design, and such an erosion would, in the opinion of this author, be a good thing.

6.3 Beyond the Boston Case

This study set out to do two things: to assemble a generic methodology to assist with making comparisons between the costs and benefits associated with park-and-ride and transit-oriented development, and to demonstrate the application of this methodology to a case study of commuter rail stations in the Boston region. The results of the case study, while perhaps interesting for planners and policy makers elsewhere, should not be assumed to accurately describe the conditions of the park-and-ride/TOD tradeoff in other contexts. The Boston region’s development pattern, employment landscape and transit system structure dictate that these results will likely have relevance only in relatively dense, mono-centric urban regions with radial transit networks. Additional limitations to the generalizability of these results arise from the great number of specific assumptions and techniques that make sense in this region but might not apply elsewhere (see §4.1.2). Instead, these results might serve as a kind of starting point for investigation to determine whether similar or very different results seem to hold in other contexts. The generic methodology outlined in Chapter 2 may provide a helpful framework for such investigation.
It aims to provide a structure for the inquiry while allowing a wide range of data, techniques and assumptions to be deployed in the problem framing and analysis.
References


